FY84

AQUATIC AND WILDLIFE RESOURCES

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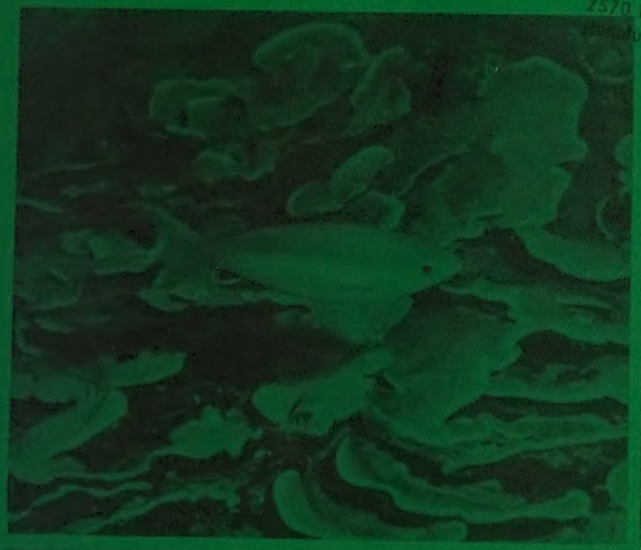

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'84

DEPARTMENT OF AGRICULTURE

OCTOBER 1, 1983 - SEPTEMBER 30, 1984
FY 1984

ANNUAL REPORT
FISCAL YEAR 1984

GUAM
AQUATIC & WILDLIFE RESOURCES DIVISION
Harry T. Kami, Chief

DEPARTMENT OF AGRICULTURE
Elizabeth P. Torres, Director

Edited By:
Robert D. Anderson
Michael E. Molina

PERIOD COVERED:
October 1, 1983 to September 30, 1984

ACKNOWLEDGEMENTS

The Aquatic & Wildlife Resources Division, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

The members of the Guam Fishing & Boating Association, the Eighth Marianas Fishing Derby Committee and the Manager of the Guam Fishermen's Coop for allowing fishery biologists to examine their fish.

All fishermen and fish weir operators who have cooperated with fishery data collection.

All farmers engaged in aquaculture who cooperated by providing information and harvest data.

All hunters who have cooperated with wildlife data collection by submitting hunter report cards.

The Base Commanders of the U.S. Naval Magazine, Naval Facility, Naval Station, Naval Communications Station and the Andersen Air Force Base.

The Security Officers and their staffs at the U.S. Naval Magazine, Naval Station, Naval Communication Station, and Andersen Air Force Base.

The Commander of the Marianas Section, U.S. Coast Guard.

The staff and management of KGTF for assistance in producing conservation related public service announcements.

The members of both print and electronic media for their assistance with our conservation education program.

The Cushing Zoo for cooperating with the Division by caring for injured wildlife.

The personnel of the Naval Oceanographic Command Detachment, U.S. Naval Air Station, Guam, for providing weather data.

Vincent Golumbeski, Alaska Fish & Game, for providing field assistance to staff fishery and wildlife biologists.

Meitsu Birkeland, for providing Taiwanese to English translations of aquaculture reports to staff fishery biologists.

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AQUATIC & WILDLIFE RESOURCES STAFF

The following persons were on the staff of the Aquatic and Wildlife Resources Division sometime during the reporting period (October 1, 1983 to September 30, 1984):

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Nancy C. Mafnas, Clerk Typist II

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GUAM FISH AND WILDLIFE INVESTIGATIONS
PROJECT FW-2R-21
Federal Aid in Fish and Wildlife Restoration Acts

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs.

PERIOD COVERED: October 1, 1983 to September 30, 1984

JOB OBJECTIVES: To plan, coordinate, supervise, and administer all fish and wildlife restoration programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.

2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Offices.

3. Administer all personnel matters including recruitment of off-island staff.

4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division Chief and his staff were involved in preparing required documentation or the DJ-PR funded Guam Fish and Wildlife Investigation Program (FW-2R) and the Guam Endangered Species Program (E-1) funded under a Section 6 Cooperative Agreement. Documentation included a new 5-year AFA, and the Project Agreements for Segment 22 and our Section 6 program.

Fiscal and budgetary activities included monthly preparation and submission of reimbursement vouchers for our various Federal Aid programs and coordination with the Government of Guam Accounting and Budget Offices to ensure fiscal integrity. An accounting firm was contacted to conduct an audit of our federal Aid programs and the audit was completed.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources.

Numerous personnel changes took place during the fiscal year. Gretchen Grimm and Bob Rinehart joined the staff as full-time Fisheries Biologists. Part-time Fisheries Biologist Evangeline Charfauros resigned and was replaced by Gerry Davis. Wildlife Biologist Celestino Aguon, who started working in a part-time position in 1978 and who joined the full-time staff in 1982, resigned in June to enter a Master's degree program at the University of Hawaii. Herman Muna joined the wildlife staff as a Biological Aid. Burrdette Satterfield and Tony Earnhardt also worked as Biological Aid during the segment.

Division staff made a number of off-island trips related to Federal Aid programs during the segment. Fisheries Biologist Michael Molina attended a Fisheries Statistics Training Workshop in Noumea, New Caledonia, which was sponsored by the South Pacific Commission. Wildlife Biologist Julie Savidge attended the Centenary meeting of the American Ornithologists Union, at which she presented a paper on the reasons for the decline of Guam's native birds. Wildlife Biologist Robert Beck escorted a shipment of Micronesian Kingfishers to mainland zoos where it is hoped that they can be successfully bred in captivity.

The Division had a number of official visitors from off-island during the year. In many cases we provided logistical support; in all cases we benefitted from direct contact with the visitors and the agencies they represent.

We were visited by a number of U.S. Fish and Wildlife Service (USFWS) personnel including Al Marmelstein, Pacific Island Administrator, and Ernie Kosaka, William Kramer, John Ford, John Engbring, and Peter Stine of his staff. Topics covered during their respective visits included endangered species listing and protection, relations with Andersen Air Force Base, development of endangered species recovery plans, and environmental impact reviews of a number of projects around the island.

Other USFWS visitors include Keith Parcher and Jim Bartee of the Regional Law Enforcement staff in Portland and Jim Micuda, Special Agent stationed on Guam. They visited to discuss endangered species law enforcement problems on Guam.

Drs. Lou Sileo and Diana Berger of the USFWS National Wildlife Health Laboratory, visited to collaborate with our staff on an intensive avian disease sentinel study, as a part of our continuing effort to ascertain the true causes of the decline of Guam's birds.

Dr. Tom Fritts of the USFWS Denver Wildlife Research Center visited to evaluate the snake problem on Guam and to consult with our staff on possible research and control methods.

We received direct assistance from several zoos during the year. Mr. John Groves, Curator of Reptiles at the Philadelphia zoo, visited Guam to evaluate the snake problem and consult with our staff.

The National Zoo sent Dr. Eugene Morton, Curator of Birds at their Conservation Research Center in Front Royal, Virginia, to Guam to assist in development of a captive breeding program for the Guam rail and other

native birds. Dr. Morton gave valuable assistance in evaluating the situation facing Guam's native birds and in developing capture techniques for the Guam rail.

Rufo Lujan, Chief of Fish and Game for the Commonwealth of the Northern Marianas, and biologists Tom Lemke, Thane Pratt, and Arnold Palacios, visited the Division at various times to discuss matters of mutual interest.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT: FW-2R-21
SUB-PROJECT NO.: C-2
JOB NO.: 1

PROJECT TITLE Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish and Wildlife Resources.

PERIOD COVERED: October 1, 1983 to September 30, 1984.

BACKGROUND

The rapid development of Guam's economy has placed increasing demands upon Guam's natural resources. A trend toward urbanization has brought growth in the construction of residential, recreational, commercial, military, industrial, and public utility facilities, all of which have some impact upon the environment. To help minimize long-term adverse impacts of such development, the Division of Aquatic and Wildlife Resources (DAWR) has taken an increasingly active role in the area of technical guidance. Recently, the DAWR's responsibilities in this area have been increasing rapidly because review is now legally required for many development plans, permit applications, and impact statements.

OBJECTIVES

1. To minimize adverse impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.

2. Provide technical assistance to military and civil agencies relative to the management and protection of fish and wildlife resources.

FINDINGS

The staff of the Division has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations have been conducted in many cases as a part of the review process.

Various Division staff members actively serve as members of the following groups:

1. Western Pacific Regional Fisheries Management Council

2. Cocos Lagoon Task Force

3. Region IX Regional Response Team - Oceania

4. Animal Import Screening Committee

5. Territorial Seashore Park Management Committee

6. Subdivision and Development Review Committee

7. Melon Fly Control Task Force

8. Task Force on Preserving Natural Resources

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the U.S. Navy, the U.S. Coast Guard, and the U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Division staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members participated in National Wildlife Week, Chamorro Week, Earth Week, Environment Fair and World Food day activities and gave talks to a number of civic groups, sportsman's clubs, and school and university classes.

Some specific Technical Assistance activities included:

1. As members of the Animal Import Screening Committee, Division staff reviewed all applications to import live organisms to Guam.

2. As members of the Cocos Lagoon Task Force, Division staff met several times to develop planning guidelines for the Merizo/Cocos Island/Cocos Lagoon area in southern Guam. One important aspect of this activity was to provide input to the U.S. Coast Guard assisting with the development of a water safety plan for this area.

3. The Division was represented on the Subdivision and Development Review Committee, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and wildlife resources be considered in land use planning.

4. Division staff attend a workshop sponsored by the U.S. Army Corps of Engineers on their Guam Comprehensive Study.

5. Division staff met monthly with supervisors of Customs and Quarantine to discuss animal imports and answer endangered species questions.

6. The Division provided information and logistical support to the U.S. Fish and Wildlife Service and the Army Corps of Engineers in planning the proposed Agana River Flood Control project.

7. The Division reviewed the Navy's application for an Army Corps of Engineers permit for construction of a floating dock in Sumay Cove.

8. The Division reviewed the Army Corps of Engineers tentative plans for construction of a small boat harbor in the Merizo area and attended public meetings held on this subject.

9. The Division reviewed the plans and Army Corps of Engineers permit application by the Department of Public Works to construct a new bridge over the Umatac River.

10. A meeting regarding planning considerations for the War in the Pacific National Park and discussing wildland fire response strategies was attended.

11. Input was provided to the Aquaculture Association regarding the needs for a prawn and fish hatchery on Guam.

12. Division staff met several times with representatives of the U.S. Fish and Wildlife Service, National Marine Fisheries Service, the U.S. Navy, and with other Government of Guam agencies to review mitigation plans for the Navy's proposed ammunition wharf at Adotgon Point. The plans of the Navy to establish two ecological reserves in mitigation were reviewed and recommendations were made for the development of management plans for these areas.

13. An analysis of fishing at the 1983 Guam International Fishing Derby and a summary of trolling data compiled at the Agana Boat Basin in FY 83 were provided to the Marianas Fishing Derby Committee for the FY 1984 program.

14. Division staff met with the Bird Strike Task Force at Andersen Air Force Base and provided recommendations regarding the reduction of bird-caused flight hazards.

15. Division staff met with the Navy Public Work Center to discuss snake-caused power outages and possible control methods.

16. Numerous animal damage complaints by farmers were investigated and control permits issued if warranted. Recommendations regarding protection of crops against animal damage were made.

17. Considerable assistance was provided the public and local veterinarians regarding avian diseases on Guam as part of our effort to determine if avian disease may be responsible for the decline of Guam's birds.

18. Technical advice regarding care and feeding of animals was provided to the Cushing Zoo.

19. Division staff worked closely with the Attorney General's Office and their Prosecution Division in regard to a number of legal issues, including the definition of wild animals, Guam's fish and game laws, and the hunting and fishing regulations.

20. The Division submitted written comments to the National Marine Fisheries Service reviewing the regulations relative to taking certain sea turtles in Guam's waters.

21. Division staff participated in the Guam Environment Fair by setting up a display.

22. Division staff provided written and oral comments regarding the proposed construction of the Nauru Hotel at Tumon Bay, Guam and the dredging of a swimming area.

23. Division staff filled many requests from the public and from local, federal, and state government agencies for information regarding Guam's fish and wildlife resources and our protective laws and regulations. Materials provided included posters, fact sheets, copies of laws and regulations, and other conservation education material.

24. Division staff responded to numerous requests from the news media for information on fish and wildlife issues. This information was provided to the press through news releases, press conferences, and direct interviews.

25. Division staff spoke to a number of civic organizations during the year on topics concerning the management and protection of Guam's fish and wildlife resources. Groups addressed include the Rotary Club of Guam, the Andersen Air Force Base Dive Club, the Islanders Sportsman's Club, the Tweed's Cave Rod and Gun Club, the U.S. Navy Dive Club, the Marianas Audubon Society and the staff of Naval Facility at Ritidian Point.

26. Division staff were participants in the Sea Grant Fisheries Workshop and presented lectures on fisheries management to workshop attendees.

27. Division staff assisted in the organization and coordination of the Governor's Symposium on Aquaculture held in conjunction with World Food Day and made a formal presentation to workshop participants.

28. Division staff provided comments to the 17th Guam Legislature on a number of proposed bills, including one to increase the penalties for certain fish and wildlife offenses, another to appropriate local funds for preservation of Guam's native birds and resolution of the snake problem, and another regarding the FY 1985 budget for the Department of Agriculture.

29. The Division reviewed numerous pieces of legislation and provided input to the Governor's Legislative Review Committee.

30. The Division provided information to the 17th Guam Legislature regarding the designation of a Territorial Fish.

31. Division staff met several times with the Departments of Parks and Recreation, Public Works, and Bureau of Planning to discuss the development of access ramps to boat launching areas in conjunction with the Pago Bay bridge and future bridge projects.

32. Division staff met with Port Authority planning consultants regarding the development of a harbor of refuge for small boats in the Piti Channel area. The Port Authorities dredging permit application was reviewed and comments were submitted to the Army Corps of Engineers.

33. Division staff met with representatives of the Bureau of Reclamation and reviewed their plans to study water development potential in southern Guam, including exploratory drilling and small impoundment development.

34. Division staff investigated a stress-related natural fish kill in Fena Lake at the request of the Navy Public Works Department. This die-off, which initially affected only large adult tilapia, was attributed to a Psuedomonas spp. outbreak believed to be related to low oxygen levels.

35. Division staff provided input to the Governor on the feasibility of deer farming and prepared a proposal at his request for federal technical assistance in conducting a feasibility study.

36. Division staff performed a number of on-site inspections of proposed development projects including subdivisions, dredging for recreational swimming areas, and various requests for zone variances and changes. Comments were submitted to developers and to the responsible government agencies.

37. Division staff reviewed numerous research project proposals and manuscripts for publication, with comments being submitted to the authors, editors or review boards.

38. Division staff provided input to the Governor for use in his State of the Territory address.

39. Division staff reviewed the Navy's application for Department of the Army Permits to repair existing sea walls Apra Harbor and Naval Station and submitted appropriate comments.

40. Division staff reviewed the Navy's tentative plans to construct a new receiver facility at NAVCAMS and submitted appropriate comments.

41. A great deal of effort was spent in consulting with and advising the Air Force at Andersen Air Force Base on matters of environmental concern. Numerous field investigations were carried out in conjunction with these activities and frequent meetings were held with Air Force personnel. Some specific topics included:

    a) Guam Rail: One of the last remaining populations of Guam rail is found in a wooded area inside the flightline fence at Andersen Air Force Base. For security reasons, the Air Force wants to clear this area. Division staff expended considerable effort consulting with the Air Force regarding probable impacts and attempting to capture those rails present in the area for use in our developing captive breeding programs. The Guam rail was emergency listed as an endangered species on April 11, 1984, largely due to the controversy created by this clearing proposal.

    b) Environmental Impact Assessment: Because most of the capture activities to acquire Guam rails and Micronesian Kingfisher for captive breeding would be conducted on lands administered by Andersen Air Force Base, our Division was required to prepare an Environmental Impact Assessment (EIA) and Findings of No Significant Impact (FONSI) for the the Air Force, in order that they comply strictly with the National Environmental Policy Act. An EIA and FONSI for each species was prepared and submitted to the Air Force.

    c) Deer Control: Because deer wandering onto runways, especially at night, can pose a significant hazard to aircraft, Division staff provided a number of recommendations to the Air Force regarding deer control in flightline areas. Recommendations included closure of existing gates, construction of perimeter fences (including electric), trapping, and controlled recreational hunting. Several special spotlight counts were conducted to assess the severity of the situation and a number of unsuccessful attempts to capture and relocate deer with the use of a tranquilizer gun were made. Ultimately the Air Force began direct control through nightly shooting, killing a total of 27 deer in 4½ months.

d) Training Exercises: Division staff conducted several field inspections and submitted comments and recommendations to the Air Force for training exercises conducted in Northwest Field.

e) Golf Course: Andersen Air Force Base desires to expand their existing golf course by an additional 9 holes. The original plans were to remove a significant area of pristine limestone forest. Division staff made a number of filed inspections and provided written comments. Golf course expansion plans have now been modified and little, if any, native forest will be impacted.

f) New 2-Lane Road: For security purposes Andersen Air Force Base desired to construct a short length of two-lane road through an area that has recently held Guam rails. After conducting a site inspection and making recommendations and comments, the Air Force has accepted our recommended alternate route.

g) Miscellaneous Technical Assistance: Other issues addressed during the year included hunting regulations, hunting seasons, roadside clearing, pesticide/herbicide usage, conservation law enforcement, and animal damage control.

Report prepared by Robert D. Anderson and Michael E. Molina

GUAM FISHERIES INVESTIGATIONS
PROJECT FW-2R-21
Federal Aid in Sport Fish Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 1

JOB TITLE: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin and other boat launching locations along Guam's shoreline from October 1983 through September 1984. An estimated 272.9 metric tons (m.t.) of finfish were landed island-wide during that period. The majority of this catch (233.0 m.t.) were harvested by trolling during an estimated 35,776 boat-hours of effort. Approximately 29.4 m.t. of bottomfish, primarily belonging to the snapper family, were also harvested during FY 84. Other fishing methods, including spearfishing and night-light jigging produced an additional 10.4 m.t. of reef fish. This years mahimahi catch totaled only 25% of last year's estimated harvest, and was down approximately 60% from the average yearly mahimahi harvest for the period of FY80 through FY 83. Similarly, the annual wahoo harvest was down approximately 67% from our FY 83 estimate. In contrast, a near 200% increase in the harvest of skipjack tuna, and a 350% increase in the Pacific blue marlin catch helped bring the overall estimated FY 84 harvest to within 99% of that for FY 83.

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used and annual harvest. In order to identify trends in fishing participation, effort and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for more than seven years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. Recently, however, major advances have been made in both field survey techniques and in the area of computerized statistical analysis. Much of this progress has resulted from the combined efforts of DAWR and National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3).

PROCEDURES

During FY 84, interviews of returning offshore fishing parties were conducted on four randomly selected days per month at the Agana Boat

Basin. In each month, two of these days were weekdays and two were holidays (which in this report includes weekend days). Each survey began at 1500 hrs. and lasted until 2100 hrs. Throughout the period no survey days were cancelled or rescheduled due to inclement weather.

Returning fishers were asked standard questions regarding fishing methods, effort, catch, areas fished etc. Questions were prioritized so that the most important information was obtained for otherwise incomplete interviews. Although attempts were made to intercept all returning boats, and to examine all catches, this was not always feasible.

During an interview each fish in the catch was measured when there was enough time to do so. Otherwise, efforts were directed at taking unbiased subsamples and all unmeasured fishes of each species were counted. Batch weights of all measured, unweighed fishes were calculated by species from known length-weight relationships. If additional data were needed to determine a valid length-weight relationship for a particular species, individuals of this species were weighed as well as measured. If adequate data were unavailable for calculating the weight of measured fish, available data on the most morphologically similar species were used.

Estimates of the number of fishing boats returning to the boat basin outside of the survey period were made. This was done in order to calculate their contribution to the total offshore fishing activity that emanated from the boat basin on each survey day. In addition, estimates of the number of active fishing boats not utilizing the boat basin on a given survey day were made. This was based on the numbers of empty trailers, berths, moorings, etc. counted at Merizo, Apra Harbor and other launch sites during inshore fishing participation surveys (see Study F-1, Job 2).

All data collected during FY 83 were entered into computerized files and expanded utilizing a program based on modifications of the algorithms outlined in the National Marine Fisheries Service Administrative Report H-83-21C (see Study F-1, Job 3). Since it was possible to obtain only an instantaneous estimate of offshore participation at launch points other than the Agana Boat Basin, a 24-hour island-wide participation estimate was made utilizing the hypothetical relationship:

$$I_p = \frac{A_t}{\overline{A}_i} \times I_i + A_p$$

Where I_p = estimated island-wide 24-hr. participation for a given day,

I_i = instantaneous island-wide counts for that day,

A_t = estimated 24 hr. participation at Agana Boat Basin,

A_i = Instantaneous participation counts at the Agana Boat Basin, and

A_p = estimated 24 hr. participation for a given day at the Agana Boat Basin.

This was done separately on data obtained during weekday and holiday survey days.

The island-wide expansion of data is based on catch rates obtained solely from information collected at the Agana Boat Basin. An expansion was done for each month and for the FY 84 year as a whole by applying the raw data to the Guam Offshore Expansion System (GOES; See Study F-1, Job 3). The output of each monthly expansion includes standard errors (SE) and 90% confidence limits (CL) for participation, effort and harvest estimates. The sums of these estimates for all months were used to derive supplemental annual estimates, although calculations of SE and 90% CL for the year were not possible by this method. In contrast, annual estimates, including SE and 90% CL were computed by the GOES for a sample size of 48 days. However, since different calculations result in different rounding errors, slightly different annual estimates are produced by the two methods. For each of the fishing methods that were analyzed, various catch rates were calculated and these included kilograms (Kg) harvested per boat-trip (B-T), boat-hour (B-H), and person-hour (P-H) of effort.

RESULTS

Trolling

Table 1 displays the estimated monthly and annual trolling participation, effort and harvest which occurred during FY 84. Readers should note that the trolling expansion was performed for a 28-day month for July, and for a 363-year, in order to exclude the time spent during the three-day Guam International Fishing Derby (GIFD; formerly called the Guam/Marianas Fishing Derby). Since DAWR fishery biologists make a complete census of the GIFD trolling activities each year, it is possible to add GIFD trolling data directly to the GOES trolling estimates to account for the three-day period, either within the month or the year. We feel this is a legitimate since the amount of trolling effort which is concentrated during the GIFD is abnormally high and representative of nearly all of the island-wide trolling effort expended during the three-day period. The 1984 GIFD results are presented further on this report and should be referred to when considering the trolling estimates in Table 1.

Excluding the GIFD results, an estimated 233.0 m.t. of troll-caught fish were landed island-wide during FY 84. Monthly catches ranged from a high of 30.3 m.t. in April to a low of 8.2 m.t. in November (Figure 1). An estimated 35,776 boat-hours were spent fishing with an average catch rate of 6.5 Kg/boat-hour. Monthly catch rates ranged from 10.1 Kg/boat-hour in December to 3.8 Kg/boat-hour in June.

As usual, five pelagic species accounted for the majority of the catch (95.8%; Table 2). These species include skipjack tuna (Katsuwonus pelamis; 48.9%), yellowfin tuna (Thunnus albacares; 20.7%), Pacific blue marlin (Makaira nigricans; 11.0%), mahimahi (Coryphaena hippurus; 8.0%) and wahoo (Acanthocybium solandri; 7.1%). Collectively, scombrids comprised 77.2% of the total trolling harvest.

Table 1. Estimated monthly and annual Guam trolling participation, effort and harvest during FY 84. July data are expanded for 28 days, and FY 84 data are expanded for 363 days. See text for explanation.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	1307	303	714	433	78	183
NOV	761	100	236	344	60	141
DEC	1131	234	551	474	93	219
JAN	1535	898	2113	521	287	674
FEB	2582	920	2166	778	294	693
MAR	2388	830	1952	721	176	414
APR	2086	834	1963	677	266	626
MAY	1961	254	597	601	52	122
JUN	1641	98	231	604	24	56
JUL	1064	214	504	417	70	163
AUG	1075	36	86	458	56	132
SEP	1422	120	282	602	73	171
TOTAL	18953			6630		
GOES	19050	1687	2841	6660	514	866

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	8525.9	2958.2	6960.6	2579.5	442.2	1040.4
NOV	4306.2	878.2	2066.4	2081.4	584.4	1290.4
DEC	5837.5	1626.4	3826.9	2556.6	897.1	2110.9
JAN	8193.7	4245.7	9990.2	2846.8	1308.4	3078.7
FEB	16367.5	7988.5	18796.9	5210.8	2600.2	6118.3
MAR	14023.1	5012.4	11794.1	4202.8	1048.6	2467.3
APR	11734.9	4275.8	10060.9	4015.4	1620.2	3812.3
MAY	8292.6	636.1	1496.7	2537.4	147.7	347.6
JUN	7732.8	1079.5	2540.0	2873.1	266.7	627.5
JUL	4216.2	192.3	452.4	1638.9	50.7	119.3
AUG	5711.1	349.1	821.4	2444.9	346.8	816.0
SEP	6190.5	514.1	1209.6	2578.9	284.3	669.0
TOTAL	101132.0			35566.5		
GOES	101752.0	11355.9	19123.4	35775.7	3580.8	6030.1

C) HARVEST:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	15489.7	2293.5	5396.6	35.8	6.0	1.8
NOV	8218.8	2600.8	6119.7	23.9	4.0	1.9
DEC	9836.0	3895.7	9166.6	20.8	3.8	1.7
JAN	26767.0	6314.4	14857.8	51.4	9.4	3.3
FEB	26645.6	18981.9	44664.5	34.2	5.1	1.6
MAR	27982.6	4876.4	11474.1	38.8	6.7	2.0
APR	30322.9	16102.9	37890.2	44.8	7.6	2.6
MAY	10908.7	3503.8	8244.5	18.2	4.3	1.3
JUN	28979.6	4062.1	9558.1	48.0	10.1	3.7
JUL	8179.0	1722.3	4052.6	19.6	5.0	1.9
AUG	20406.1	1058.0	2489.5	44.6	8.4	3.6
SEP	17719.7	6953.6	16361.7	29.4	6.9	2.9
TOTAL	231455.7			34.9	6.5	2.3
GOES	232986.4	29279.0	49305.9	35.0	6.5	2.3

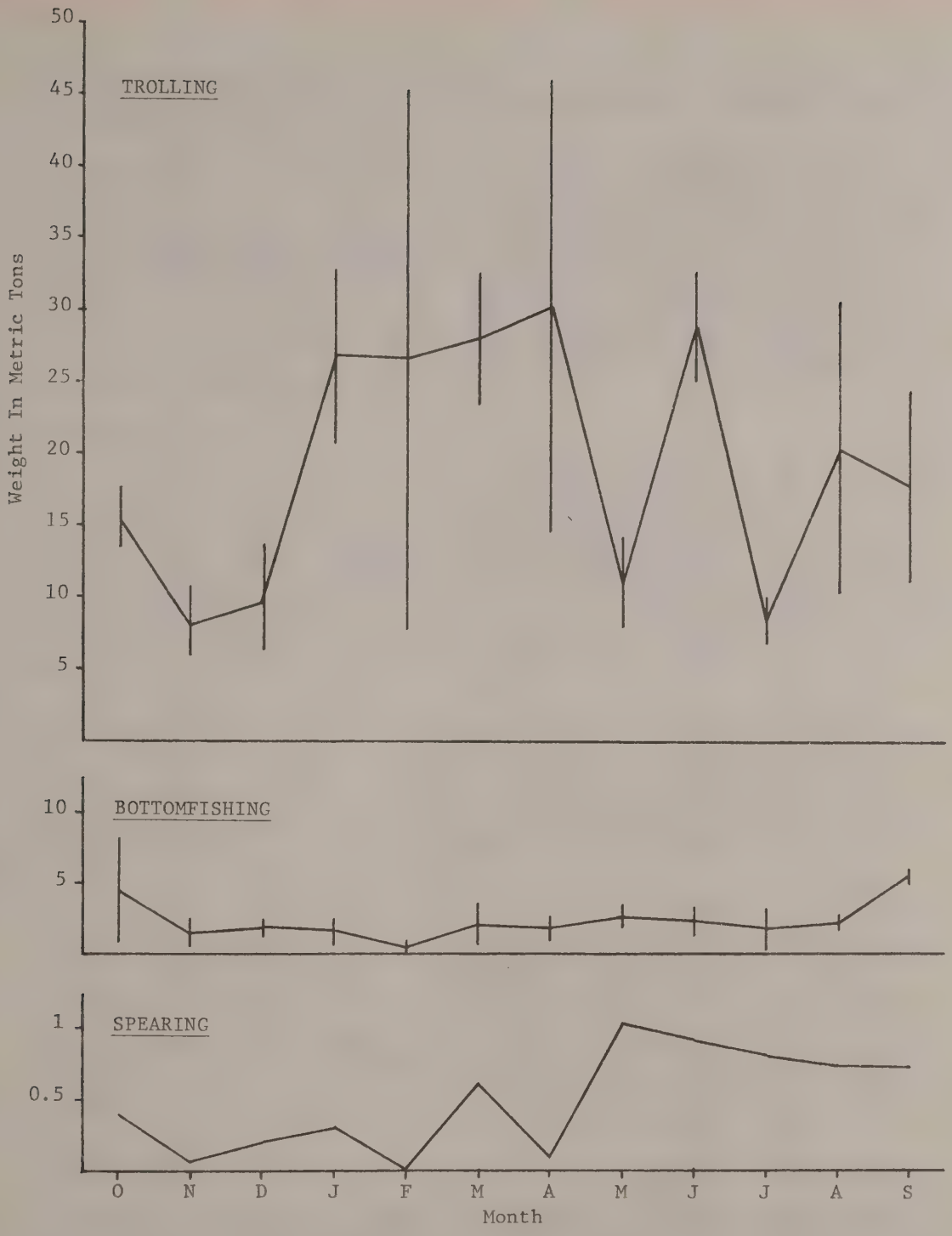


Figure 1. Monthly fluctuations in the estimated Guam offshore fish harvests during FY 84. The trolling estimate for July is based on a 28-day month, and does not include the 3-day 1984 GIFD catch which totaled 5466 Kg. The scale for spearing is ten times the scale for trolling and bottomfishing.

Table 2. Monthly and annual composition of the Guam trolling harvest during FY 84. Estimated weights are in metric tons.

FAMILY AND SPECIES	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% TOTAL
* Orectolobidae														
Nebrius ferrugineus							0.2						0.2	0.1
Carangidae														
Caranx spp.											0.1		0.1	<0.1
Elagatis bipinnulatus				0.1	0.8			<0.1	<0.1	<0.1		<0.1	1.2	0.5
Coryphaenidae														
Coryphaena hippurus	0.2	0.9	1.6	1.2	7.4	6.0	1.0	0.3					18.6	8.0
Sphyraenidae														
Sphyraena barracuda	0.3	0.2	0.1	3.7	0.7	0.2	1.0	0.1		0.2	0.2	0.1	6.8	2.9
Scombridae														
Acanthocybium solandri	2.3	4.2	3.6		1.6	0.8	1.3	0.6	0.4	0.3	0.3	1.1	16.5	7.1
Euthynus affinis		<0.1		0.1			0.1		0.2		<0.1		0.6	0.3
Gymnosarda unicolor		<0.1	<0.1				0.1		0.2		<0.1		0.5	0.2
Katsuwonus pelamis	2.4	1.2	1.3	14.6	5.7	11.6	20.5	7.8	21.4	4.7	10.3	11.9	113.4	48.9
Thunnus albacares	6.8	1.2	2.0	3.4	10.5	9.5	4.8	1.2	2.0	0.7	3.8	2.1	48.0	20.7
Istiophoridae														
Makaira nigricans	3.5	0.4	1.2	3.7			1.3	0.7	4.2	2.3	5.7	2.5	25.5	11.0
Istiophorus platypterus									0.5				0.5	0.2
Others								0.1					0.1	0.1
TOTAL	15.5	8.2	9.8	26.8	26.7	28.1	30.3	10.9	29.0	8.2	20.4	17.7	232.0	100.0

* Erroneously entered under trolling has since been corrected on the GOES data base.

Figure 2 illustrates the monthly harvest fluctuations exhibited by the five dominant species.

While this year's estimated trolling harvest was only slightly lower than that of FY 83, there were some notable differences in the harvest of certain species. For example, this year's mahimahi catch totaled only 25% of last years estimated mahimahi harvest, and was down approximately 60% from the average yearly mahimahi harvest for the period of FY 80 through FY 83. Similarly, the annual wahoo harvest was down approximately 67% from our FY 83 estimate. Conversely, a near twofold increase in the harvest of skipjack tuna, and a 350% increase in the Pacific blue marlin catch served to offset the relatively low take of mahimahi and wahoo.

Bottomfishing

The estimated monthly and annual bottomfishing participation, effort and harvest which occurred during FY 84 is shown in Table 3. An estimated 29.4 m.t. of bottomfish were harvested island-wide. Monthly catches ranged from a high of 5.6 m.t. in September to a low of 0.5 m.t. in February. In general, the largest monthly catches occurred from May through October (Figure 1). An estimated 8,467 boat-hours were spent bottomfishing, resulting in an overall catch rate of 3.5 Kg/boat-hour. Monthly catch rates ranged from 1.8 Kg/boat-hour in February to 8.3 Kg/boat-hour in August.

As usual, the most important bottomfishes were snappers (Lutjanidae) which collectively comprised approximately 48.0% of the take (Table 4). The major deep-water species included yellowtail kalikali (Pristipomoides auricilla), opakapaka (P. flavipinnis), lehi (Aphareus rutilans), ehu (Etelis carbunculus) and onaga (E. coruscans). The most important shallow-water snappers included kakaka(Lutjanus fulvus) and uku (Aprion virescens).

The second most important family within the bottomfish catch was Lethrinidae (emperors) which accounted for just over 28% of the take. This was primarily due to the harvest of the red-gilled emperor (Lethrinus rubrioperculatus), locally referred to as a type of "Mafute". Other important families included Carangidae (jacks; 10.7%) and Serranidae (groupers; 7.6%). Lesser quantities of goatfishes (Mullidae; 1.6%), surgeonfishes (Acanthuridae; 1.6%), triggerfishes (Balistidae; 1.1%) and others were also landed from relatively shallow depths.

Spearfishing

Tables 5 and 6 summarize the estimated monthly and annual participation, effort and harvest for spearfishing from boats during FY 84. Readers should also refer to Study F-1, Job 2 for estimates of spearing from shore (i.e., without the use of boats) to gain a more complete picture of FY 84 spearfishing activities on Guam.

An estimated 5.7 m.t. of speared fish were landed from boats during FY 84. Approximately 3.6 m.t. were taken by snorkelers and 2.1 m.t.

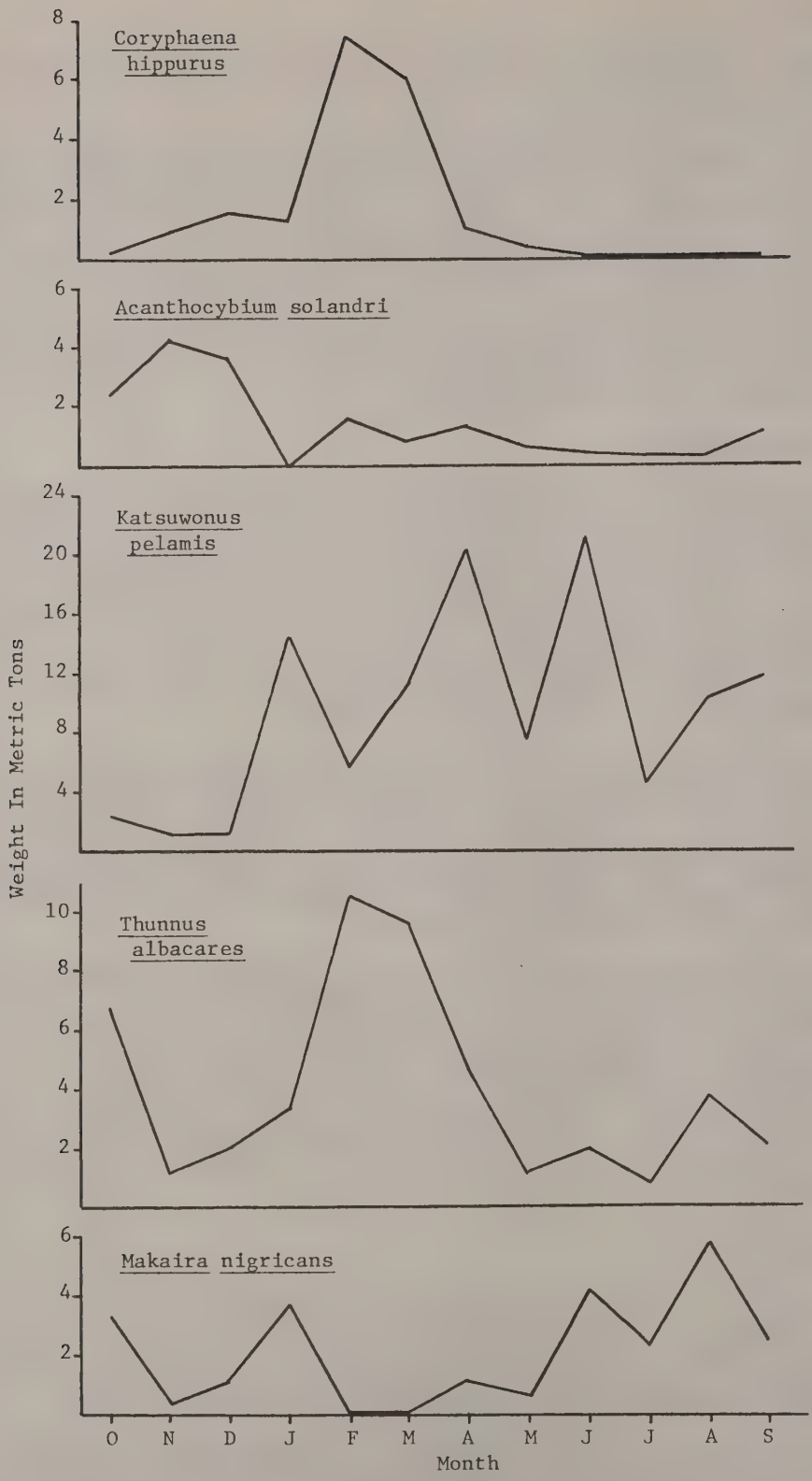


Figure 2. Fluctuations in the estimated harvest of Guam's major troll-caught species during FY 84. July estimates are a 28-day month and does not include the 3-day 1984 GIFD catches.

Table 3. Estimated monthly and annual Guam bottomfishing participation, effort and harvest during FY 84. See text for explanation.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90%CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	268	98	231	133	27	64
NOV	209	66	156	149	62	146
DEC	579	71	167	270	30	71
JAN	364	215	506	140	69	163
FEB	278	128	301	153	83	194
MAR	136	89	208	60	39	93
APR	379	94	221	159	32	75
MAY	596	225	529	179	46	108
JUN	494	70	164	200	44	105
JUL	391	207	487	180	102	240
AUG	1108	102	240	349	33	78
SEP	1048	34	79	394	6	15
TOTAL	5850			2366		
GOES	5940	673	1133	2402	238	400

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	2440.1	1819.5	4281.3	905.2	600.3	1412.4
NOV	264.5	172.5	405.8	234.5	172.1	404.9
DEC	1693.5	88.4	207.9	797.4	29.5	69.3
JAN	1347.7	860.0	2023.7	494.1	289.9	682.2
FEB	642.3	367.2	864.1	300.8	167.5	394.1
MAR	895.3	661.0	1555.4	376.3	269.5	634.0
APR	1599.0	351.6	827.4	653.0	68.2	160.6
MAY	2188.4	488.1	1148.5	674.0	72.9	171.5
JUN	2174.0	525.6	1236.8	894.5	292.7	688.6
JUL	747.8	520.2	1224.1	344.9	240.5	566.0
AUG	632.9	422.2	993.3	292.7	195.7	460.6
SEP	3742.2	1813.6	4267.4	1297.1	635.1	1494.4
TOTAL	18367.7			7264.5		
GOES	21790.7	3047.9	5132.6	8466.6	1051.3	1770.4

C) HARVEST:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	4494.7	3936.5	9262.5	33.8	5.0	1.8
NOV	1492.5	1258.9	2962.2	9.9	6.3	5.6
DEC	2013.4	679.7	1599.4	7.5	2.5	1.2
JAN	1549.3	970.3	2283.2	11.1	3.1	1.2
FEB	528.8	205.9	484.5	3.5	1.8	0.8
MAR	2181.9	1651.1	3885.1	36.4	5.8	2.4
APR	1834.4	875.8	2060.6	11.5	2.8	1.2
MAY	2681.0	867.7	2041.6	15.0	4.0	1.2
JUN	2350.4	1172.1	2757.9	11.8	2.6	1.1
JUL	1888.5	1613.3	3796.0	10.5	5.5	2.5
AUG	2422.6	367.8	865.5	6.9	8.3	3.8
SEP	5657.5	511.8	1204.1	14.4	4.4	1.5
TOTAL	29085.0			12.3	4.0	1.6
GOES	29428.3	5066.8	8532.5	12.2	3.5	1.4

Table 4. Composition of the Guam bottomfishing harvest during FY 84. Estimated weights are in kilograms. Percents are based on the differentiated portion of the catch only.

FAMILY	WEIGHT (Kg)	%
Holocentridae (Squirrelfishes)	17.2	0.1
Serranidae (Groupers)	1143.6	7.6
Priacanthidae (Bigeyes)	17.2	0.1
Carangidae (Jacks)	1618.6	10.7
Lutjanidae (Snappers)	7245.3	48.0
Lethrinidae (Emperors)	4235.3	28.1
Nemipteridae (Monocle Breams)	8.5	0.1
Mullidae (Goatfishes)	247.8	1.6
Labridae (Wrasses)	144.3	1.0
Acanthuridae (Surgeonfishes)	238.7	1.6
Balistidae (Triggerfishes)	162.3	1.1
SUBTOTAL	15078.8	100.0
Undifferentiated Fishes	14006.2	
TOTAL	29085.0	

Table 5. Estimated monthly and annual Guam offshore spearfishing (with snorkel) participation, effort and harvest during FY 84. See text for explanation.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	62	43	100	27	20	47
NOV	0	0	0	0	0	0
DEC	0	0	0	0	0	0
JAN	91	87	204	15	14	34
FEB	0	0	0	0	0	0
MAR	92	87	205	23	22	51
APR	34	30	71	7	6	14
MAY	48	3	6	14	1	2
JUN	83	8	19	17	2	4
JUL	154	146	344	44	42	98
AUG	93	81	190	27	23	54
SEP	210	76	178	37	11	25
TOTAL	867			211		
GOES	898	250	422	220	63	106

B) EFFORT:

MONTH	NO. OF PERSON HOURS	SE	90% CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	202.9	154.3	363.1	93.7	75.6	177.8
NOV	0.0	0.0	0.0	0.0	0.0	0.0
DEC	0.0	0.0	0.0	0.0	0.0	0.0
JAN	456.5	434.2	1021.8	76.1	72.4	170.3
FEB	0.0	0.0	0.0	0.0	0.0	0.0
MAR	45.9	43.6	102.6	11.5	10.9	25.7
APR	202.4	181.1	426.0	40.5	36.2	85.2
MAY	215.5	32.6	76.8	61.3	1.7	4.1
JUN	213.0	56.6	133.3	42.6	11.3	26.7
JUL	461.9	438.2	1031.0	132.0	125.2	294.6
AUG	420.0	363.7	855.9	120.0	103.9	244.5
SEP	1052.4	46.8	110.2	191.1	7.1	16.7
TOTAL	3270.5			769.8		
GOES	3389.2	969.0	1631.7	806.4	230.2	387.6

C) HARVEST:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	60.6	42.0	98.8	2.2	0.6	0.3
NOV	0.0	0.0	0.0	0.0	0.0	0.0
DEC	0.0	0.0	0.0	0.0	0.0	0.0
JAN	82.8	78.7	185.3	5.5	1.1	0.2
FEB	0.0	0.0	0.0	0.0	0.0	0.0
MAR	520.4	495.0	1164.8	22.6	45.2	11.3
APR	91.8	82.1	193.1	13.1	2.3	0.4
MAY	535.0	9.1	21.5	38.2	8.7	2.5
JUN	226.0	21.6	50.9	13.3	5.3	1.1
JUL	622.4	590.5	1389.4	13.4	4.7	1.3
AUG	734.7	636.2	1497.1	23.6	6.1	1.7
SEP	692.9	377.1	887.4	10.2	3.6	0.7
TOTAL	3567.4			16.9	4.6	1.1
GOES	3842.2	1214.5	2045.2	17.5	4.8	1.1

Table 6. Estimated monthly and annual Guam offshore spearfishing (with SCUBA) participation, effort and harvest during FY 84. See text for explanation.

A) PARTICIPATION:

MONTH	NO. OF PERSONS	SE	90% CL	NO. OF BOAT-TRIPS	SE	90% CL
OCT	51	26	60	44	25	59
NOV	18	17	41	18	17	41
DEC	28	25	60	14	13	30
JAN	15	14	34	15	14	34
FEB	0	0	0	0	0	0
MAR	92	87	205	23	22	51
APR	0	0	0	0	0	0
MAY	52	13	30	52	13	30
JUN	54	37	86	32	21	49
JUL	46	32	76	35	24	56
AUG	0	0	0	0	0	0
SEP	25	22	53	6	6	13
TOTAL	381			239		
GOES	371	105	177	231	53	90

B) EFFORT:

MONTH	NO. OF PERSON-HOURS	SE	90%CL	NO. OF BOAT-HOURS	SE	90% CL
OCT	102.8	51.1	120.2	87.2	50.0	117.7
NOV	36.7	34.8	81.9	36.7	34.8	81.9
DEC	56.1	50.7	119.4	28.0	25.4	59.7
JAN	60.9	57.9	136.2	60.9	57.9	136.2
FEB	0.0	0.0	0.0	0.0	0.0	0.0
MAR	275.1	261.7	615.7	68.8	65.4	153.9
APR	0.0	0.0	0.0	0.0	0.0	0.0
MAY	136.1	56.8	133.6	136.1	56.8	133.6
JUN	219.1	155.6	366.1	118.7	76.9	180.8
JUL	79.3	61.0	143.6	57.3	41.8	98.3
AUG	0.0	0.0	0.0	0.0	0.0	0.0
SEP	150.0	134.2	315.7	37.5	33.5	78.9
TOTAL	1116.1			631.2		
GOES	1092.7	340.8	573.8	612.3	150.2	253.0

C) HARVEST:

MONTH	NO. OF KILOGRAMS	SE	90% CL	Kg/B-T	Kg/B-H	Kg/P-H
OCT	333.3	153.4	361.0	7.6	3.8	3.2
NOV	76.7	72.8	171.2	4.3	2.1	2.1
DEC	180.0	97.7	229.8	7.7	3.9	1.9
JAN	207.6	197.4	464.6	13.8	3.4	3.4
FEB	0.0	0.0	0.0	0.0	0.0	0.0
MAR	29.8	28.3	66.7	1.3	0.4	0.1
APR	0.0	0.0	0.0	0.0	0.0	0.0
MAY	471.2	183.6	431.9	9.1	3.5	3.5
JUN	674.7	441.9	1039.8	21.1	5.7	3.1
JUL	207.9	170.0	400.1	5.9	3.6	2.6
AUG	0.0	0.0	0.0	0.0	0.0	0.0
SEP	14.4	12.9	30.3	2.4	0.4	0.1
TOTAL	2123.6			8.9	3.4	1.9
GOES	2066.9	598.9	1008.5	9.0	3.4	1.9

were harvested by SCUBA divers. An estimated 1,419 boat-hours of fishing effort were expended by spearfishers (806 boat-hours by snorkelers; and 631 boat-hours by SCUBA divers). The average catch rate for spearfishing was approximately 4.0 Kg/boat-hour. Since spearfishing parties frequently return late at night, beyond our survey period, we are sure that the above estimates are low. Additional data on spearfishing activities must be obtained before more accurate estimates can be made. Surveys of nighttime spearfishing activities will be initiated during FY 85.

Parrotfishes (Scaridae; 31.5%), wrasses (Labridae; 24.3%), and squirrelfishes (Holocentridae; 15.1%) appeared to dominate the FY 84 spearfishing catch (Table 7). Other important families included groupers (Serranidae; 8.2%), snappers (Lutjanidae; 6.4%), rudderfishes (Kyphosidae; 4.5%) and sweetlips (Haemulidae; 2.6%). In addition to finfish, an undetermined quantity of spiny lobsters, octopi, and other organisms were harvested by spearfishers.

Other Methods

Other offshore fishing methods are practiced infrequently at Guam. The most common of these are night-light jigging for atulai (Selar crumenopthalmus), longlining and ika shibi fishing. Unfortunately, since the latter two methods are employed so infrequently, and are normally not encountered by samplers during the predominantly daytime survey period, we cannot make any FY 84 estimates for them. However, based on limited data, we estimate that approximately 4.5 m.t. of atulai were landed from boats island-wide during FY 84. This catch resulted from 293.8 boat-hours of fishing effort, at an average catch rate of 15.2 Kg/boat-hour. In addition, another 0.1 m.t. of finfish was landed through the use of various other rarely used methods. We hope that by extending our sample period to include early morning as well as late night hours more accurate estimates for such methods may be produced for FY 85.

Overview

Excluding the 1984 GIFD trolling catch, an estimated 272.9 m.t. (90% CL = 51.5 m.t.) of finfish were landed island-wide by boats utilizing a variety of methods beyond the reef during FY 84. An estimated 9591 boat trips were made in which 46,010 boat-hours were spent fishing. Average daily participation was estimated at 16 boats per weekday, and 34 boats per holiday. The overall monthly catch rates (Kg/boat-hour) ranged from 3.5 in December to 8.2 in January and June, with an average of 5.9. Trolling accounted for 85.4% of the total harvest (233.0 m.t., 90% CL = 49.3 m.t.). Bottomfishing comprised 10.8% of the total harvest (29.4 m.t.; 90% CL = 8.5 m.t.). Spearfishing with snorkel gear contributed 0.8% of the total harvest (2.1 m.t.; 90% CL = 0.6 m.t.). Spearfishing with SCUBA accounted for 1.4% of the total harvest (3.8 m.t.; 90% = 0.8 m.t.). Jigging for atulai and the use of other rare methods accounted for the remaining 1.6% of the total harvest.

Table 7. Composition of the Guam spearfishing harvest during FY 84. Percents are of the differentiated portion of the catch only.

FAMILY	SNORKEL (Kg)	%	SCUBA (Kg)	%	TOTAL (Kg)	%
Orectolobidae (Nurse Sharks)	46.3	6.0			46.3	2.0
Holocentridae (Squirrelfishes)	7.9	1.0	339.9	22.2	347.8	15.1
Serranidae (Groupers)			189.0	12.4	189.0	8.2
Apogonidae (Cardinalfishes)			1.6	0.1	1.6	0.1
Carangidae (Jacks)	30.5	4.0			30.5	1.3
Lutjanidae (Snappers)	9.3	1.2	137.7	9.0	147.0	6.4
Haemulidae (Sweetlips)			60.0	3.9	60.0	2.6
Lethrinidae (Emperors)			7.9	0.5	7.9	0.3
Mullidae (Goatfishes)			34.4	2.2	34.4	1.5
Kyphosidae (Rudderfishes)	25.2	3.3	77.6	5.1	102.8	4.5
Ephippidae (Batfishes)			4.6	0.3	4.6	0.2
Labridae (Wrasses)	520.4	67.7	38.9	2.5	559.3	24.3
Scaridae (Parrotfishes)	105.4	13.7	620.4	40.5	725.8	31.5
Acanthuridae (Surgeonfishes)	23.5	3.1	9.0	0.6	32.5	1.5
Scombridae (Tunas)			11.4	0.7	11.4	0.5
SUBTOTAL	768.5	100.0	1532.4	100.0	2300.9	100.0
Undifferentiated Fishes	2798.9		591.2		3390.1	
TOTAL	3567.4		2123.6		5691.0	

RECOMMENDATIONS

The estimates presented in this report are somewhat biased toward the method of trolling. This is due to the fact that during our survey period (1300 to 2100 hours) trolling parties are the most likely types of fishers to be encountered. During FY 85 we plan to extend our survey period to more adequately sample fishing activities which frequently extend into nighttime hours. Therefore, we recommend that this job continue and that sampling techniques continue to be refined. Furthermore, we recommend that staff fisheries biologists continue to work closely with NMFS personnel in improving the efficiency and accuracy of our computerized data analysis techniques.

Report prepared by: Michael E. Molina

PROJECT TITLE: Guam International Fishing Derby

PERIOD COVERED: July 14-16, 1984

INTRODUCTION

This year, the Guam International Fishing Derby (GIFD), held on July 14, 15, and 16, 1984, was sponsored by the Guam Fishermen's Cooperative Association. The organizational efforts of the Derby Committee chaired by Mr. Steven W. Phillips made this year's event a successful one. The fisheries biologists from the Division of Aquatic & Wildlife Resources (DAWR) wish to thank the committee for their assistance, and also the competing anglers for their cooperation in providing catch information. This cooperation always helps make our job easier and more enjoyable, as well as insures a more accurate analysis of derby statistics.

Awards were presented to the anglers who landed the first, second, and third heaviest fishes of the following species: blue marlin (Makaira nigricans), yellowfin tuna (Thunnus albacares), wahoo (Acanthocybium solandri) and mahimahi (Coryphaena hippurus). As in past derbies, awards were also given for the greatest 3-day total number of fish caught in the above categories combined, as well as for the largest fish caught in a ladies category, and in a children under age 16 category. Records were also kept in an "other species" category.

PARTICIPATION

As in the past, onshore check-out/check-in stations were set up at the Agana Boat Basin and the Merizo Pier (Figure 1). Daily participation information is listed in Table 1. A total of 185 separate boat trips were recorded during this year's derby with 78.9% (146) of these trips originating from the Agana Boat Basin. Each boat carried an average of 3.1 anglers per trip and pulled an average of 4.0 lines per trip, compared to last year's figure of 2.8 anglers per trip pulling an average of 4.1 lines. The mean length of fishing trip made during the 1984 GIFD was 9.1 hrs., slightly higher than that of last year's derby (7.6 hrs.).

THE CATCH

A total of 472 fish weighing 5466.4 kg was reported for the 1984 GIFD. This total comprises the four main derby species as well as the "other species" category. Table 2 presents the 1984 derby catch record by date and check-in location. The mean catch per boat trip was 29.5 kg, compared to last year's mean catch rate of 20.5 kg. The catch comparisons among the four principal derby species for all Guam or Marianas Fishing Derbies since 1977 are presented in Table 3.

Seventy-nine blue marlins were caught this year, which is more than twice the 1981 record of 34. The total weight was 3645.9 kg with a range between 15.7 and 215.4 kg. The mean weight was 46.1 kg.

The yellowfin tuna catch numbered 91 individuals weighing 479.1 kg. They ranged in weight from 2.3 kg to 51.7 kg., and had a mean weight of 5.3 kg.

A total of 84 wahoo were landed, surpasing that of all previous derbies and these weighed a total of 595.3 kg. The weights ranged between 3.4 and 21.3 kg with a mean weight of 7.1 kg.

This year was a very bad year for mahimahi; none were brought in during the GIFD.

The "other species" category included 218 fish that weighed a total 746.1 kg. By weight, 98.5% of these were skipjack tuna (Katsuwonas pelamis, 192), 1.1% were barracuda (Sphyraena barracuda), 18), 0.1% were rainbow runner (Elagatis bipinnulatus, 2) and the remaining 0.3% were dogtooth tuna (Gymnosarda unicolor, 6).

FISHING AREAS

Table 4 presents the 1984 GIFD catch by species, date and strike area. The areas listed in this table may be located in Figure 1.

As in the past three derbies, excluding the other species category, all of the winning catches were made on Guam's southern waters. Both the winning blue marlin and the wahoo were landed in Area 70 [11 mi. (17 mi.) Reef]. The prize-winning yellowfin was hooked in Area 85 (Galvez Bank).

This years' most productive areas, by overall weight and numbers, respectively, were Area 70 (20.0% and 9.2%), Area 85 (18.0% and 11.7%) and Area 4 (14.8% and 42.6%). Although Area 4 produced the highest percentage by number of fish, it had the least percentage by weight. When considering these figures, it is important to remember that strike areas were reported only for fish which were ultimately landed, and that most but not all anglers reported this information.

Report prepared by: Evangeline T. Charfauros

Table 1. Daily participation in Guam International Fishing Derby (GIFD).

Date	No. Boats	No. Trips	Avg. Trip Hrs.	No. Persons	Avg. Pers/Trip	No. Lines	Avg. Lines/Trip
Agana:							
14 July	49	52	9.4	148	2.8	205	3.9
15 July	46	49	9.0	156	3.2	187	3.8
16 July	42	45	9.3	141	3.1	179	4.0
TOTAL	137	146	9.2	445	3.0	571	3.9
Merizo							
14 July	15	16	7.9	50	3.1	65	4.1
15 July	14	15	9.9	51	3.4	73	4.9
16 July	7	8	9.2	24	3.0	36	4.5
TOTAL	36	39	9.0	125	3.2	174	4.5
COMBINED TOTAL	173	185	9.1	570	3.1	745	4.0

Table 2. Daily catch for the 1984 GIFD.

Date	Blue Marlin No.	Blue Marlin Kg.	Yellowfin No.	Yellowfin Kg.	Wahoo No.	Wahoo Kg.	Mahimahi No.	Mahimahi Kg.	Other Species No.	Other Species Kg.	Total No.	Total Kg.
Agana:												
14 July	20	1007.9	28	141.1	14	103.2	0	0.0	80	205.4	142	1457.6
15 July	23	836.0	24	136.4	17	101.1	0	0.0	73	296.5	137	1370.0
16 July	27	1113.9	27	89.0	22	124.0	0	0.0	53	206.5	129	1533.4
TOTAL	70	2957.8	79	366.5	53	328.3	0	0.0	206	708.4	408	4361.0
Merizo:												
14 July	4	427.2	8	98.6	11	75.9	0	0.0	2	0.6	25	602.3
15 July	3	172.5	4	14.0	7	74.5	0	0.0	8	30.8	22	291.8
16 July	2	88.4	0	0.0	13	116.6	0	0.0	2	6.3	17	211.3
TOTAL	9	688.1	12	112.6	31	267.0	0	0.0	12	37.7	64	1105.4
COMBINED TOTAL	79	3645.9	91	479.1	84	595.3	0	0.0	218	746.1	472	5466.4

Table 3. Catch comparisons for all Guam or Marianas Fishing Derbies*
Weights are expressed in Kilograms (1 kg = 2.2 lbs)

	1977	1978	1979	1980	1981	1982	1983	1984
MARLIN								
no. caught	9	9	6	12	34	12	13	79
total weight (kg)	933.0	511.0	703.0	727.0	2005.0	852.0	964.1	3645.9
avg. weight (kg)	103.6	56.8	117.2	60.6	59.0	71.0	74.2	46.1
winning fish (kg)	192.0	75.2	328.0	139.0	145.0	132.0	199.1	215.4
YELLOWFIN								
no. caught	18**	11	34	50	109	205	100	91
total weight (kg)	240.0	255.0	637.0	308.0	1156.0	2377.0	1105.7	479.1
avg. weight (kg)	13.3	23.2	18.7	6.2	10.6	11.6	11.1	5.3
winning fish (kg)	46.3	56.8	67.7	51.1	47.7	61.1	55.7	51.7
WAHOO								
no. caught	7	9	11	12	33	60	36	84
total weight (kg)	90.9	102.0	116.0	161.0	543.0	264.0	359.7	595.3
avg. weight (kg)	13.0	11.4	10.5	13.4	16.5	4.4	10.0	7.1
winning fish (kg)	22.3	18.9	19.7	23.4	17.0	22.7	24.5	21.3
MAHIMAHI								
no. caught	2	4	5	3	1	14	33	0
total weight (kg)	13.6	26.4	52.6	39.3	0.8	63.7	195.2	-
avg. weight (kg)	6.8	6.6	10.5	13.1	-	4.6	5.9	-
winning fish (kg)	8.9	8.9	14.8	15.9	0.8	14.8	11.1	-
TOTAL CATCH								
no. caught	36	33	56	77	177	291	182	254
total weight (kg)	1277.5	894.4	1508.6	1235.3	3708	3556.7	2624.7	4720.3

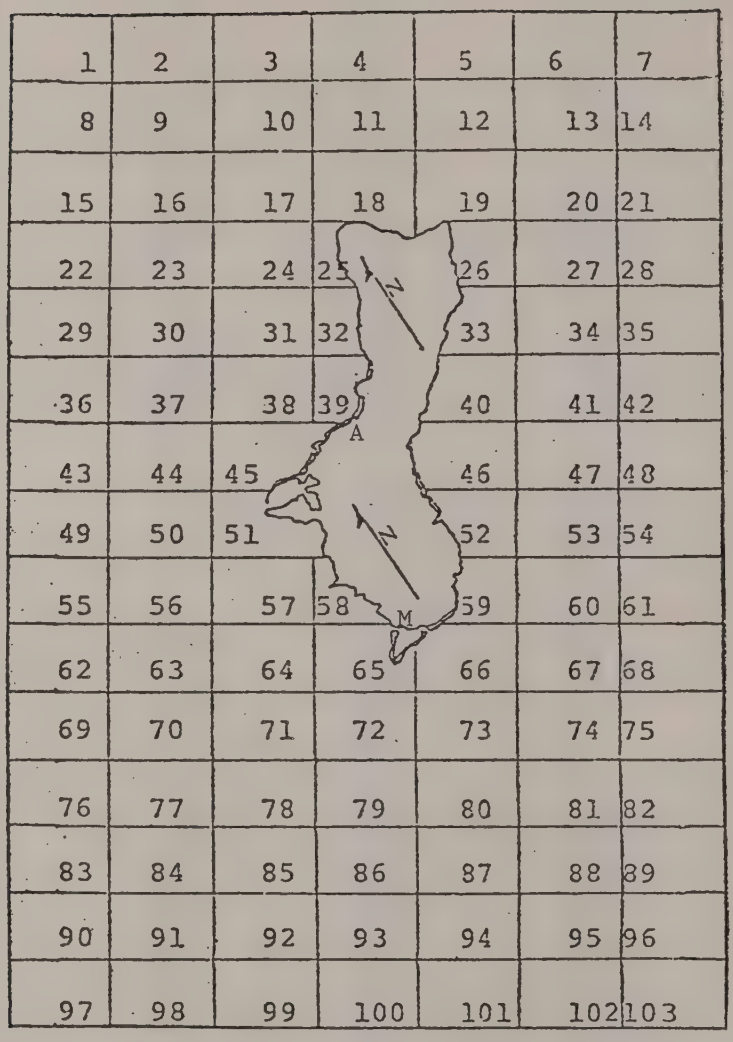
*Based on return catch reports. Only the principal derby species are included.
**Includes all tuna species.

Table 4. Number of fishes caught during the 1984 GIFD by species, date and area of catch (Also see Fig. 1). This table includes only those landed fishes for which area data were reported. No mahimahi were caught during this year's contest.

AREAS:	2	3	4	10	12	17	18	19	24/25	29	30	31	32
BLUE MARLIN:													
14 July	3		1	1		-	-		-	-	1	1	1
15 July	-		2			1	1		-	2	-	-	-
16 July	-		-			-	-		2	-	-	2	-
TOTAL	3		3	1		1	1		2	2	1	3	1
AVG. WT. (Kg)	69.6		53.0	45.8		39.0	39.7		49.7	66.2	54.1	55.0	47.6
YELLOWFIN:													
14 July	1	2	2		6	-	1	4	-			-	2
15 July	-	-	1		-	8	-	1	-			1	-
16 July	-	-	3		-	-	-	3	2			-	-
TOTAL	1	2	6		6	8	1	8	2			1	2
AVG. WT. (Kg)	4.3	5.7	6.6		4.3	8.1	4.6	5.5	5.9			6.8	6.7
WAHOO:													
14 July			1	-			1	1		-			
15 July			1	1			-	-		-			
16 July			7	-			-	2		1			
TOTAL			9	1			1	3		1			
AVG. WT. (Kg)			12.0	14.5			10.1	10.8		11.3			
OTHER SPECIES:													
14 July			57					2	1				
15 July			9					-	-				
16 July			-					-	-				
TOTAL			66					2	1				
AVG. WT. (Kg)			3.0					3.0	1.4				
ALL CATEGORIES:													
No. Caught	4	2	84	2	6	9	3	13	5	3	1	4	3
% Total No.	2.0	1.0	42.6	1.0	3.1	4.6	1.5	6.6	2.6	1.5	0.5	2.0	1.5
Kg. Caught	213.0	11.3	499.9	60.3	25.6	104.2	54.4	82.7	112.5	143.7	54.4	171.9	61.0
% Total Kg.	6.3	0.3	14.8	1.8	0.8	3.1	1.6	2.4	3.3	4.2	1.6	5.1	1.8

Table 4. (Cont.)

AREAS:	36	38	39	45	51	58	70	85	10	TOTAL
BLUE MARLIN:										
14 July	-	-	-		1	-	3	3		15
15 July	-	-	-		-	1	1	3		11
16 July	1	2	3		1	-	1	1		13
TOTAL	1	2	3		2	1	5	7		39
AVG. WT. (Kg)	51.2	61.1	56.4		50.0	45.8	109.2	64.4		63.5
YELLOWFIN:										
14 July					-			6		24
15 July					2			1		14
16 July					-			-		8
TOTAL					2			7		46
AVG. WT. (Kg)					11.7			11.3		7.2
WAHOO:										
14 July				1		-	2	5	1	12
15 July				-		1	2	3	2	10
16 July				-		-	4	-	-	14
TOTAL				1		1	8	8	3	36
AVG. WT. (Kg)				8.6		6.8	11.8	9.1	12.8	11.0
OTHER SPECIES:										
14 July					1		-	-		61
15 July					-		5	1		15
16 July					-		-	-		-
TOTAL					1		5	1		76
AVG. WT. (Kg)					1.4		6.0	1.8		3.1
ALL CATEGORIES:										
No. Caught	1	2	3	1	5	2	18	23	3	197
% Total No.	0.5	1.0	1.5	0.5	2.6	1.0	9.2	11.7	1.5	100
Kg Caught	51.2	61.1	169.1	8.6	124.7	52.6	670.6	604.0	38.5	3375.3
% Total Kg.	1.5	1.8	5.0	0.2	3.7	1.6	20.0	18.0	1.1	100.0



FISHING AREA NUMBERS;
FILL IN ON OTHER SIDE
GRID SCALE:
APPROX. 5 mi. x 8mi.
4 = Rota Bank
12 = 45° Bank
24/25 = Ritidian Pt.
19 = Pati Pt.
25 = Uruno Pt.
39 = Hospital Pt.
51 = Orote Pt.
70 = 11mi. (17mi.) Reef
85 = Galvez Bank
100 = Santa Rosa Reef

Figure 1. The island of Guam with GIFD fishing areas.
A = Agana Boat Basin; M = Merizo Pier.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 2

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October 1983 through September 1984. An estimated 98.5 metric tons (m.t.) of finfish, accounting for 111 species and 45 families, were caught by inshore fishers during FY 84. The majority of this catch (88.2 m.t.) was harvested through the use of five major inshore fishing methods during an estimated 161,602 person-hours, or 129,387 gear-hours of fishing effort. Hook and line fishing was the most popular inshore method, accounting for 59% of the total estimated inshore fishing participation. Hook and line fishing and gill netting each resulted in the harvest of approximately 26 m.t. of finfish. Surround netting was the most successful method in terms of catch rate, yielding approximately 10.54 kg/gear-hour. Beyond this, approximately 22.4 m.t. of marine invertebrates and algae were harvested during the year. Our FY 84 annual estimates are markedly larger than previous annual estimates. Presumably this is based on two factors. FY 84 experienced relatively large seasonal inshore fish runs, and this year's data expansion incorporated a ratio of "fishable hours" per survey period to total "fishable hours" per day for each fishing method.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational/subsistence fishing activities have come to be based on more reliable data analysis techniques.

OBJECTIVES

1. To estimate the total annual inshore participation, effort and harvest of Guam's inshore recreational/subsistence fisheries through statistically valid surveys and analyses.

2. To gather limited biological data that will add to a long-term historical data base on Guam's important inshore fish species.

PROCEDURES

During FY 84, fishing participation surveys were conducted on six randomly selected days per month; four on weekdays and two on holidays (which in this report also include weekend days). These surveys entailed making visual observations of not only participation among the various fishing methods employed, but also of the reef zones and general locations that were fished within the more readily accessible portions of Guam's coastline (Fig. 1, locations 1-72). Based on data collected during nine years of aerial surveys, conducted between FY 63 and FY 79, approximately 85% of Guam's inshore fishing activities is known to occur within this area. The starting location for each survey was selected at random and the "circular" direction of driving was alternated between surveys. Observations were made while driving the route once without backtracking.

In addition, fishers within one of three survey regions (Fig. 1) were interviewed for catch and effort data over a six-hour interval (starting at 0800 hrs.) on four randomly selected days per month. Since previously collected data have shown that Region 1 receives a greater amount of fishing pressure than do the other two regions, increased survey time was allocated to this area. Therefore, interviews were conducted in Region 1 once on a weekday and once on a holiday each month. In contrast, interviews were conducted only once a month in the remaining two regions based on an alternating weekday/holiday pattern.

Our FY 84 data expansion resulted from applying the following formulae to the raw data on each fishing method separately for each month in order to obtain annual estimates.

Participation

$$P = Pw + Ph$$

where P is the estimated total number of participants; and
Pw and Ph are the estimated numbers of people fishing on weekdays and holidays, respectively.

Pw and Ph are calculated as follows:

$$Pw = [(cw \div sw) \div (fs \div fd)] \quad w$$

$$Ph = [(ch \div sh) \div (fs \div fd)] \quad h$$

where cw and ch are the total numbers of people counted during weekday and holiday participation surveys, respectively;

Fig. 1. Inshore Fisheries Survey Location Codes.

sw and sh are the total numbers of weekday and holiday participation surveys, respectively;

fs and fd are the average numbers of "fishable hours" per participation survey period, and per 12-hour day, respectively

w is the total number of weekdays.

h is the total number of holidays.

Note: Gear units (i.e., Gw and Gh) may be calculated similarly by substituting gear counts (gw and gh) for person counts (cw and ch).

Effort

$$P\text{-}H = (Tw \times P\text{-}Hwt) + (Th \times P\text{-}Hht)$$

$$G\text{-}H = (Tw \times G\text{-}Hwt) + (Th \times G\text{-}Hht)$$

where P-H and G-H are the estimated total numbers of person-hours and gear-hours spent fishing, respectively;

P-Hwt and P-Hht are the average numbers of person-hours spent fishing per weekday and holiday trip, respectively;

G-Hwt and G-Hht are the average numbers of gear-hours spent fishing per weekday and holiday trip, respectively; and

Tw and Th are the estimated numbers of fishing trips made on weekdays and holidays, respectively.

Tw and Th are calculated as follows:

$$Tw = Gw \div gwt$$

$$Th = Gh \div ght$$

where gwt and ght are the average numbers of gear units per fishing trip counted on weekdays and holidays, respectively.

Catch

$$C = G\text{-}H\ (Kg \div agh)$$

where C is the estimated total catch in kilograms of fish;

Kg is the actual kilogram-weight of harvested fish as recorded in the catch and effort interviews; and

agh is the actual number of gear-hours expended to harvest those fish.

The monthly catch rates that were used to expand the survey data to annual estimates were derived from combined weekday and holiday information collected in all three sampled regions. This was done for each fishing method except for hook and line fishing in Region III. This method was expanded separately for Region III due to the finding of a significant difference in hook and line catch rate for that region (see Study F-1, Job 3). Differences in catch rates for cast net, gill net, surround net and spearfishing with snorkel gear were found to be nonsignificant both between weekdays and holidays, and among regions.

Finally, the average daily number of "fishable hours" in each month was determined separately for each fishing method based on tidal limitations. That is, the potential 12-hour daytime fishing period was reduced for certain methods based on the limitations imposed on those methods by the tide. This "fishable hours" factor is incorporated into the expansion by multiplying the average amount of participation observed per fishable hour of the participation survey period by the average number of fishable hours possible per 12-hour weekday or holiday for the month.

RESULTS

An estimated 88.2 m.t. of finfish were harvested through the use of five primary inshore fishing methods during FY 84. This catch resulted from a total effort of 161,602 person-hours or 129,387 gear-hours of fishing effort. Overall, approximately 0.55 and 0.68 kg of fish were taken per person-hour and gear-hour, respectively. Estimated participation, effort and harvest values for each of these fishing methods are shown in Tables 1-5.

As in previous years, hook and line fishing was the most popular method, accounting for 59% of the participation and 57% of the person-hours estimated for the five primary inshore fishing methods. Success with hook and line, however, still remains lower than any of the other fishing methods, averaging 0.26 kg/gear-hour. Despite this, hook and line fishing produced 22.5 m.t. or approximately 26% of the total finfish catch indicated above.

Combined participation and effort involved in the various net fishing methods was less than that of hook and line fishing (Table 6). The most popular net fishing method was gill netting which accounted for 15% of the total participation, and 21% of the total person-hours, estimated for the five primary methods. Gill netting also produced 26% of the harvest attributed to these five methods, at an overall catch rate of 1.39 kg/gear-hour.

Cast netting appeared to be slightly less popular and approximately half as productive as gill netting. In contrast, surround netting was the least popular net fishing method; but in terms of catch rate (10.54 kg/gear-hour) was the most productive of all five of the primary methods.

Spearfishing is the most difficult fishing method to census. Spearfishermen are often invisible or inaccessible to interviewers. For this reason, we consider our spearfishing estimates to be very conservative. The data show that spearfishing with snorkel gear provided over 18% of the annual finfish harvest, with a catch rate of 1.76 kg/gear-hour. Due to

Table 1. Estimated monthly and annual Guam hook and line participation, effort and harvest during FY84.

Month	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
OCT	2,464	2,526	2,011	6,168.48	5,034.47	1,732.15
NOV	1,780	1,680	1,333	8,320.31	7,449.27	2,167.16
DEC	1,450	1,480	728	8,933.10	6,474.05	2,471.21
JAN	1,264	1,276	589	3,826.16	4,294.13	1,108.73
FEB	870	802	455	2,802.72	2,982.81	221.74
MAR	1,007	944	517	2,653.00	2,308.00	420.09
APR	1,170	1,030	761	2,754.48	2,751.79	317.75
MAY	992	958	824	1,899.03	1,898.57	402.84
JUN	3,590	3,500	2,550	13,478.17	11,292.83	1,212.04
JUL	4,460	4,449	2,553	12,773.04	11,588.08	2,242.07
AUG	6,790	6,746	3,227	16,180.03	17,649.33	5,333.49
SEP	4,860	4,860	2,122	12,578.42	12,165.55	4,839.88
TOTAL	30,697	30,251	17,670	92,366.94	85,888.88	22,469.15

Table 2. Estimated monthly and annual Guam cast net participation, effort and harvest during FY 84.

Month	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
OCT	567	507	507	1,146.49	991.35	314.69
NOV	650	530	473	2,637.52	2,784.85	2,589.81
DEC	417	365	332	759.76	1,015.58	555.32
JAN	186	166	166	420.34	420.34	975.19
FEB	149	149	102	522.92	462.17	976.82
MAR	201	153	153	265.70	265.70	173.57
APR	887	634	608	2,162.95	1,664.70	494.91
MAY	966	740	645	2,542.58	2,356.52	1,364.30
JUN	626	494	494	2,080.02	1,608.67	1,657.55
JUL	659	486	431	3,759.27	2,151.49	1,847.13
AUG	641	558	404	1,724.37	1,193.49	834.04
SEP	583	526	526	1,568.16	1,568.16	399.88
TOTAL	6,532	5,308	4,841	19,590.08	16,483.02	12,183.21

Table 3. Estimated monthly and annual Guam gill net participation, effort and harvest during FY 84.

Month	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
OCT	566	303	303	1,213.52	1,213.52	296.71
NOV	630	370	370	2,580.08	1,451.20	4,879.66
DEC	468	269	269	1,422.25	565.75	3,074.73
JAN	264	153	153	950.12	343.13	324.63
FEB	57	34	34	174.07	87.08	44.51
MAR	222	124	124	646.98	566.45	1,801.32
APR	567	297	297	1,782.00	1,639.80	320.15
MAY	1,149	492	492	788.48	1,822.41	257.94
JUN	1,037	501	501	3,347.62	2,247.40	3,121.63
JUL	888	444	444	8,825.52	1,904.98	5,546.24
AUG	1,046	519	519	7,977.98	2,971.24	3,384.42
SEP	689	377	377	3,569.80	1,829.29	103.66
TOTAL	7,583	3,865	3,865	33,278.42	16,642.25	23,155.60

Table 4. Estimated monthly and annual Guam surround netting participation, effort and harvest during FY 84.

Month	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
OCT	171	30	30	372.30	77.37	1,051.45
NOV	320	21	21	663.80	122.80	1,668.84
DEC	211	20	20	402.80	81.58	1,108.66
JAN	139	20	20	377.99	78.56	1,067.63
FEB	327	37	37	866.80	154.86	2,104.45
MAR	131	19	19	345.88	71.89	976.99
APR	239	32	32	542.34	117.99	71.13
MAY	364	45	45	857.59	175.30	4,151.84
JUN	280	39	39	897.16	161.13	837.98
JUL	304	38	38	915.90	160.46	176.50
AUG	195	23	23	387.48	85.98	58.46
SEP	234	26	26	485.94	100.10	1,360.36
TOTAL	2,915	350	350	7,115.98	1,388.02	14,634.38

Table 5. Estimated monthly and annual Guam spearfishing (with snorkel gear) participation, effort and harvest during FY 84.

Month	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
OCT	516	516	224	861.16	861.16	905.75
NOV	220	190	143	664.10	664.10	1,188.62
DEC	449	449	274	1,563.66	1,563.66	3,544.29
JAN	320	300	128	270.92	270.92	297.47
FEB	163	163	98	345.43	345.43	26.39
MAR	240	240	175	576.27	521.14	71.79
APR	300	280	245	507.50	297.50	157.68
MAY	446	412	344	1,881.20	1,881.20	4,215.25
JUN	526	507	422	717.75	717.75	2,430.78
JUL	444	341	341	170.50	170.50	99.52
AUG	374	363	82	1,051.68	1,051.68	2,149.74
SEP	400	400	200	640.00	640.00	712.86
TOTAL	4,398	4,161	2,676	9,250.17	8,985.04	15,800.14

Table 6. Percent contribution of estimated annual participation, effort and harvest by inshore fishing method for FY 84.
P-H = person-hour; G-H = gear-hour.

Method	% Persons	% Gear Units	% Trips	% P-H	% G-H	% Harvest
Hook & Line	59.9	68.9	60.1	57.2	66.4	25.5
Cast Net	12.5	12.1	16.5	12.1	12.8	13.8
Gill Net	14.5	8.8	13.1	20.6	12.8	26.2
Surround Net	6.7	0.8	1.2	4.4	1.1	16.6
Spear	8.4	9.4	9.1	5.7	6.9	17.9
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

insufficient information, estimates of annual harvest for spearfishing with SCUBA equipment were not possible.

The seasonal harvest of certain juvenile fishes is widely anticipated by local fishers. The FY 84 harvest was marked by large numbers of juvenile goatfish (tiao) especially during March and April; juvenile rabbitfish (manahac) during April, May and June; and juvenile jacks (e'e') primarily during July and August. In addition, the harvests of Selar crumenopthalmus (atulai) which were made this year were relatively large throughout an unusually long season; runs started in mid-May and remained strong beyond the end of the fiscal year. In addition, large numbers of juvenile fusiliers (Caesionidae) were caught inshore during late June and July. These were often mistaken by local fishers as juvenile rainbow runners (Elagatis bipinnulatus). These relatively large runs of seasonal fish may have been the result of unusual weather experienced during the late portion of 1983 and early in 1984. In addition, unusually low seasonal harvests of certain offshore fish were taken during FY 84 which suggests that predation upon larval reef fish may have been temporarily reduced (see Study F-1, Jobs 1 and 8).

In general, the harvests of tiao and e'e' are fairly well represented within the estimates given in Tables 1-5. However, the take of manahac and atulai are not well represented due to the highly sporadic nature of the harvest, the randomness of our present survey methods, and of our current limitations in personnel. Making accurate estimates for such harvests would require intensive survey effort during the time periods in which these fish are exploited. Even so, we are fairly confident that this year's manahac and atulai harvests far exceeded those of any of the last several years. Based on limited observations of harvest frequency and average catch, we estimate at least 1.5 m.t. of manahac and 8.8 m.t. of atulai were harvested during the year.

In conjunction with the effort levels displayed for the five primary fishing methods in Table 6, a comparison of catch rates for all inshore fishing methods with respect to different time units is presented in Table 7. These catch rates indicate a general measure of the efficiency of harvest attributed to each method with regard to the time unit in question (i.e., trips, person-hours, or gear-hours).

In addition to finfish, a significant amount of other organisms were harvested from the reefs throughout the year. For example, the estimated gaff and hook catch (Table 8) amounted to nearly 3.3 m.t., and was totally comprised of octopus which was harvested at the rate of 0.48 kg/gear-hour. Beyond this, "other methods" (Table 9) were responsible for the harvest of an estimated 19.1 m.t. of various crustaceans, gastropods, bivalves, echinoderms and algae at an overall catch rate of 1.45 kg/person-hour of fishing effort.

Finally, it should be mentioned that our FY 84 estimates are considered to be conservative due to the lack of information on nighttime fishing activities. However, between May and September of this fiscal year, nighttime surveys of fishing activities were begun. The survey methods employed were nearly identical to those used during surveys of daytime fishing. Although night fishing activities were not estimated for this

Table 7. Summary of annual catch rates by inshore fishing method for FY 84. *** = not calculated due to wide diversity of gear types used.

Gear	Kg/Trip	Kg/Person-hour	Kg/Gear-hour
Hook and Line	1.27	0.24	0.26
Cast Net	2.52	0.62	0.74
Gill Net	5.99	0.70	1.39
Surround Net	41.81	2.06	10.54
Spear	5.90	1.71	1.76
Gaff and Hook	4.39	0.71	0.48
"Other Methods"	6.46	1.45	***
TOTAL	68.34	7.49	15.17

Table 8. Estimated monthly and annual Guam gaff and hook participation, effort and harvest during FY 84.

Month	No. of Persons	No. of Gear Units	No. of Trips	Person-Hours	Gear-Hours	Catch (Kg)
OCT	57	42	18	110.06	162.86	78.17
NOV	40	40	17	107.58	159.20	76.42
DEC	62	62	35	213.74	316.30	151.82
JAN	94	94	56	347.51	514.24	246.83
FEB	67	29	17	102.38	151.50	72.72
MAR	52	52	32	195.42	289.18	138.81
APR	196	183	100	617.33	913.52	438.17
MAY	363	320	168	1,037.57	1,535.40	736.99
JUN	61	61	37	230.88	341.67	164.00
JUL	236	225	117	726.58	1,075.20	516.09
AUG	98	117	76	469.76	695.16	333.59
SEP	120	131	74	458.31	678.20	325.53
TOTAL	1,446	1,356	747	4,617.12	6,832.43	3,279.14

Table 9. Estimated participation effort and harvest attributed to "Other Methods" during FY 84.

Month	No. of Persons	No. of Trips	Person-Hours	Catch Kg
OCT	300	133	593.41	860.45
NOV	220	98	435.12	630.92
DEC	266	118	525.10	761.40
JAN	112	50	220.54	319.79
FEB	142	63	280.84	407.22
MAR	181	80	357.96	519.04
APR	343	152	678.76	984.20
MAY	1,720	765	3,402.60	4,933.77
JUN	1,378	612	2,725.53	3,952.02
JUL	1,390	618	2,751.08	3,989.06
AUG	164	73	325.16	471.48
SEP	460	204	909.58	1,318.90
TOTAL	6,676	2,966	13,205.68	19,148.25

report, the trial survey period provided us with information necessary to begin a formal nighttime survey in FY 85.

RECOMMENDATIONS

In FY 84, modifications in data collection and analysis resulted in a more accurate assessment of Guam's inshore fishing activities. The aid of a computer system greatly enhanced the analysis process.

Guam is currently participating in a region-wide program of reviewing and analyzing fisheries data for incorporation into the Western Pacific Fisheries Information Network (WPACFIN). Through the WPACFIN, progress is being made in developing a computer program capable of estimating annual inshore harvest based on raw data collections similar to that being used in assessing Guam's offshore fisheries. Since the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Work in developing more efficient survey and analysis techniques for inshore fisheries assessment should also be continued, including extending surveys into the night. Finally, serious consideration should be given to temporarily reinstituting the aerial surveying of inshore fishing activities within this job, in order to update our assessment of surveyed inshore fishing participation in relation to that for the whole island.

Report prepared by: Gerald Davis and Michael E. Molina

PROJECT TILE: Fish Weir Report

PERIOD COVERED: October 1, 1983 to September 30, 1984

There were six licensed weirs in the Merizo/Cocos Lagoon area for FY 84 (Figure 1). A total of 7,485.8 kg with 989 days of operation were reported from a total of 72 monthly reports. There was some theft reported at Site 4 and Site 5. To estimate the amount of catch stolen, the average daily catch rate was calculated for each month (not including the days the catch was stolen). The average daily catch value was then multiplied by the number of days the catch was stolen. This estimates 323.7 kg of stolen fish, increasing the estimated total harvest to 7,809.5 kg.

The reported catch composition for FY 84 is similar to that of FY 83. The dominant families were Mullids (20.4%), Lethrinids/Lutjanids (19.3%), Leiognathids* (17.6%), and Carangids** (12.7%) (Table 1).

The average harvest per day varied from 1.81 kg, at Site 5, to 18.02 kg, at Site 3. The mean daily catch rate for all six sites ranged from 4.08 kg/day in November to 10.38 kg/day in June with an overall mean of 7.57 kg/day for the entire year. The six weirs were operated an average of 164.8 days. Site 1 was operated the greatest amount of time (347 days) and Site 6 was operated the least amount of time (77 days) (Table 2). The reason given for the low number of operating days at Site 6 was the unavailability of materials to repair the weir.

The estimated catch of 7,809.5 kg is an increase of 13.8% over that of FY 83, but is 7.2% below the record level of 8,413 kg estimated for FY 80. Although there was a decrease of 17.0% in the operating time of the weirs, the increased harvest could be due to the frequent replacement of wires and regular maintenance of the weirs.

Report prepared by: Timothy Sherwood

*Weir operators report "Guaguas" which refers to both Leiognathids and Gerreids.
**Not including Selar crumenopthalmus

Table 1. Composition of the reported fish weir catch for FY 84.

Fish Family	Reported Catch (Kg)	Percent (%) of Reported Total Catch
Acanthuridae (Surgeonfishes, Hugupao)	84.2	1.1
Carangidae* (Jacks, Tarakito)	948.1	12.7
Carangidae *S. crumenopthalmus* (Atulai)	458.6	6.1
Leiognathidae/Gerreidae (Soapys, Guaguas)	1317.4	17.6
Lethrinidae/Lutjanidae (Emperors, Mafute)	1443.8	19.3
Mugilidae (Mullets, Laiguan)	691.3	9.2
Mullidae (Goatfishes, Salmoneti)	1530.7	20.4
Serranidae (Groupers, Gadao)	38.8	0.5
Siganidae (Rabbitfishes, Sesjun)	160.2	2.1
Others	812.7	10.9
TOTAL	7485.8	100.0

*Excluding *Selar crumenopthalmus*

Table 2. Average daily catch rates (Kg/day) for the licensed fish weirs operating in the Merizo/Cocos Lagoon region during FY 84.

Site	Location	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	FY 84	No. of Days in Operation
1	Tamogi-Afgo	16.17	6.30	5.45	2.15	4.86	6.47	11.49	16.38	12.48	15.23	10.16	14.03	10.10	347
2	Hasta-Sagua Dano	-	-	6.75	7.27	-	-	-	-	11.52	9.75	8.31	6.82	8.40	91
3	Aaguan-Acho-Dekiki**	-	-	-	-	-	-	15.83	18.02	11.53	-	-	-	15.3	83
4	Sagua Usao-Ton Vicente	2.02	2.42 (2.95)	3.91 (5.03)	7.31 (8.64)	5.30 (6.19)	3.43 (4.37)	3.98 (4.65)	3.84 (4.32)	-	-	-	-	4.03 (4.77)	185 (158)
5	Aba-Aang	2.08	3.52 (7.05)	7.04 (7.75)	3.20 (3.71)	4.95 (6.01)	7.07 (8.71)	3.90 (5.11)	6.71 (7.27)	5.99	3.60 (4.26)	1.81 (2.01)	-	4.53 (5.54)	206 (178)
6	Saugua Usao-Manpua	-	- 4.08	3.81 5.39	- 4.98	- 3.72	- 5.66	3.95 7.83	4.27 9.84	-	- 9.53	- 6.76	10.23	5.57 7.99	77 989
	All Sites***	6.76	(5.43)	(5.76)	(5.44)	(5.67)	(6.52)	(8.21)	(10.05)	10.38	(9.75)	(6.83)	10.36	(8.28)	(934)

*Numbers in parentheses are based only on days in which the catch was not stolen.
**To avoid a user conflict with a Cocos Is. resort development, Site 3 was moved a short distance in July and is now located from Mana Puntan Unai.
***Means for all six sites combined are based on an average of each site's monthly mean. The mean daily catch rate for all sites combined was 7.57 kg/day (8.01 kg/day).

Figure 1. Merizo/Cocos Lagoon, Southwestern Guam. The numbers indicate the locations of fish weir sites licensed during FY 84.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-2
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 3

JOB TITLE: Fisheries Data Processing

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

During FY 84, offshore fisheries data back through FY 80 were transferred to computer files and reanalyzed for monthly and annual catch, effort, and participation estimates. The inshore data bases were modified to disassociate seasonal variations of certain fish species that may adversely influence the calculation of estimated annual harvest. Data entry on new inshore participation, Recreationally Important Reef Fish, and Pelagic Fish Feeding data bases was completed and several summary reports were produced. As of September 30, 1984, the total number of computer stored records is 40,575.

BACKGROUND

Although marine fishing activities on Guam have been surveyed by the Division of Aquatic and Wildlife Resources (DAWR) since mid-1960, data collected prior to 1977 have been determined unreliable from a statistical point of view. Since 1977, inshore fisheries data collection methods have been refined and improved and, in 1977, the DAWR formally began its offshore fisheries survey. As a result, an enormous amount of fisheries data has been collected and a means of storing and retrieving this data was needed for efficient and expeditious analysis. Since computerization has come to be viewed as a viable avenue for documentation and quality control of the DAWR's fisheries data bases, Job 3, Fisheries Data Processing, was initiated in FY 79.

In 1980, the Western Pacific Fisheries Information Network (WPACFIN) was created to provide the Western Pacific Regional Fisheries Management Council with coordinated access to fisheries data needed for management purposes. Guam has participated in the WPACFIN through the membership of the DAWR. Since its beginning, Job 3 has been jointly funded by the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the Western Pacific Regional Fisheries Management Council. Since the requirements for the WPACFIN program were established in FY 82, major advances in Job 3 have been made.

OBJECTIVES

The objectives of Job 3 for the past fiscal year were as follows:

1. Computerize the DAWR's current and, as much as possible, historical marine fisheries data and transfer finalized fisheries data files and reports to NMFS personnel in Honolulu, Hawaii for regional WPACFIN application.

2. Increase the efficiency and statistical reliability of data collection and analysis in order to obtain the most reliable estimates of the total inshore and offshore island-wide harvests.

3. Establish data bases for selected harvested fish species and pelagic fish feeding data in order to provide an efficient means for biological and statistical analysis.

RESULTS

During FY 84 the DAWR's micro-computer system continued to be upgraded to accommodate the increasing amount of data being processed. The hardware inventory now includes two Apple II+ computers with 64K RAM capacity each, four Apple disk drives, two Epson MX-100 printers, a Corvus 20 MEG hard disk with Omninet disk server, and a Magnovox tape back-up system.

The software library was also upgraded to consist of various commercial and "in-house" packages. Over the past fiscal year, the primary software packages used by the DAWR were DB Master, Visicalc, Visiplot, the Guam Offshore Expansion System (GOES), and numerous statistical programs.

During this fiscal year, efforts were directed primarily at 1) updating current and historical offshore and inshore fisheries data bases, 2) estimating annual catch, effort, and participation for the offshore and inshore fisheries, and 3) providing data analysis support for biological studies of recreationally important reef and pelagic fishes.

Offshore Fisheries Survey

The estimated annual catch, effort, and participation for the offshore fisheries were calculated manually until FY 83 when a usable computerized offshore data base format was developed. During FY 84, efforts were made to enter the historical data onto data bases and recalculate estimated annual catch and effort values by using the GOES.

The GOES is a software package written by NMFS personnel specifically for the DAWR's offshore fisheries survey. It is a menu-driven program that uses the internally stored offshore data records to calculate a monthly and annual catch estimate, and a % species composition for the various methods employed. This program was refined by DAWR and NMFS personnel over the past fiscal year.

Before the catch, effort, and participation estimates can be calculated by using the GOES, certain expansion parameters must be manually calculated

and entered into the program. These include two proportionality constants and a 24-hour participation count for each survey day. The first proportionality constant (P1) is a ratio relating the proportion of fishing activity occurring in a given sample period at a given sample location to the activity occurring over the entire 24-hour day at that same location. P1 is easily calculated by dividing the number of boats surveyed at the Agana Boat Basin (ABB) on each sample day by the total number of boats that fished out of the ABB for the day. A separate P1 is calculated for each method used during the day. The second proportionality constant (P2) is a ratio relating the proportion of 24-hour fishing activity occurring at a given sample location to the 24-hour fishing activity occurring island-wide. At the present time, the offshore expansion is based entirely on the interviews obtained from the ABB. The P2 is calculated by the following equation:

$$\frac{At}{[(xAt/xAi) * Ii] + At} = P2$$

where; $\bar{x}At$ = the mean total 24-hour participation at the ABB for the month.

$\bar{x}Ai$ = the mean instantaneous participation at the ABB for the month.

Ii = the instantaneous participation at the other boat landings for each survey day.

At = the 24-hour participation at the ABB for each survey day.

The assumption that must be made in order to qualify the P2 is that the catch-per-unit-effort (CPUE) for the surveyed boats at the ABB is the same for all boats that fished out of the other landings.

The GOES expansion analysis is a 3-step process. First, expanded catches are calculated for each sample day. Then, an average weekday and holiday (including weekend days) catch is calculated. Applying these averages and weighing them according to the number of weekdays and holidays in the month, an average daily catch is derived. Finally, the average daily catch is applied to the total number of days in the month to obtain the estimated total catch and catch breakdown for each method employed during that month. A standard error and 90% Confidence Limits are also calculated.

The species composition program module of the GOES uses the expanded monthly catch to derive an estimated harvest for each species surveyed during the month. The ratio of the weight of each species sampled to that of the total weight sampled is applied to the expanded catch and an estimate of the total catch of each species is obtained. Also, the total harvest of each species is further broken down into a percentage caught for each method.

The final analysis performed by the GOES is a total annual catch, effort, and participation estimate. By appending the monthly sort files into one large fiscal year sort file, the annual expanded catch is calculated by using every sample day over the entire year. By using more sample data for the expansion, better confidence is obtained on the estimated annual rather

than monthly catches. But, by doing so, a certain amount of the effects of seasonality inherent in some of the common offshore fish species is forfeited.

During the past fiscal year, offshore data entry was completed for FY 79 through FY 84. Presently, there are on file a total of 8381 offshore records covering a period from October, 1978 to September, 1984. The GOES was used to recalculate the monthly and annual harvest estimates for FY 80 through FY 84 only (see Study F-1, Job 1). FY 79 will be reanalyzed at a later time.

Inshore Fisheries Survey

So far, data entry has been completed from FY 80 through FY 84 with a total of 20,044 records. There are two types of inshore data bases. The "inshore-catch" data base is used to store the catch, effort, and species information obtained from the survey interviews. There are a total of 12,270 "inshore-catch" records on file. The "inshore-participation" data base is used to store the "island-wide instantaneous counts" of fishermen, gear units, and the locations of activity (see Study F-1, Job 2). These data bases contain 7774 records total.

As of September 30, 1984, only a preliminary copy of the Guam Inshore Expansion System (GIES) has been received by the DAWR. As it is written, the current copy will not provide a valid statistical analysis. Further consultation during FY 85 with NMFS personnel should yield a workable GIES. Although the micro-computer was not used to derive monthly and annual expansions of the inshore survey data, it was utilized to generate several summary reports of the raw data for the FY 84 analysis. Also, it was used to statistically test the differences in catch rates between weekdays and holidays, and among inshore survey regions for each of the five most popular inshore fishing methods.

The inshore catch data from FY 80 through FY 84 were used to calculate a mean annual catch rate for hook and line, cast net, gill net, surround net, and spear with snorkel for weekdays and holidays from each of the three inshore survey regions. A t-test analysis indicated that the mean annual catch rate for each method and region did not differ significantly between weekdays and holidays ($P > .025$, Table 1). Another t-test performed on the data showed that the mean annual catch rate for each particular method did not differ significantly among survey regions, except for hook and line fishing in Region 3 ($P < .01$, Table 2). Therefore, with this exception, monthly catch rates for each inshore fishing method may be calculated from lumped region and type day data and these catch rates can be used to calculate an expanded catch for the entire island. In order to derive an accurate expanded catch for the hook and line method, Region 3 must be surveyed at least as many times as Region 1 and/or Region 2. Thus, our inshore survey methods for FY 84 were modified to reflect this finding.

During this fiscal year the inshore data base was modified slightly in order to avoid an analytical problem posed by the inclusion of certain large seasonal catches in the annual data expansion. Since certain species of fish are harvested on Guam only during specific times of the year and with unique types of fishing gear, including these catches in the analysis would

Table 1. A t-test comparing the mean CPUE's (kg/gear-hour) for weekdays (W) and holidays (H) for the five most commonly used inshore methods on Guam. The mean CPUE's were calculated by method for each of the three inshore survey regions (see Study F-1, Job 2). NS = Not significant (P > .025).

Method by Region	Mean W CPUE $\bar{x}\pm$(SD)	N	Mean H CPUE $\bar{x}\pm$(SD)	N	t	P
Hook and line						
Region 1	0.35±0.10	5	0.26±0.06	5	1.71	NS
Region 2	0.32±0.09	5	0.29±0.10	5	0.42	NS
Region 3	0.49±0.16	5	0.41±0.12	5	0.89	NS
Cast net						
Region 1	0.72±0.35	5	0.62±0.69	5	0.29	NS
Region 2	0.65±0.54	5	0.59±0.22	5	0.23	NS
Region 3	0.93±0.35	5	0.59±0.43	5	1.36	NS
Gill net						
Region 1	1.51±1.18	5	1.75±0.60	4	0.36	NS
Region 2	0.80±0.12	5	0.79±0.29	5	0.10	NS
Region 3	1.56±0.60	5	1.16±0.99	5	0.77	NS
Surround net						
Region 1	2.51±2.04	4	4.30±0.88	5	-1.79	NS
Region 2	0.93±0.83	2	3.82±1.94	5	-1.94	NS
Region 3	4.68±2.45	3	5.19±4.25	5	-0.19	NS
Spear (snorkel)						
Region 1	1.85±±.56	4	1.95±0.93	4	-0.10	NS
Region 2	1.77±1.18	4	1.44±0.67	4	0.47	NS
Region 3	1.20±0.96	5	1.66±0.95	5	-0.76	NS

Table 2. A t-test comparing the mean CPUE's (kg/gear-hour) of the three inshore survey regions for the five most commonly used inshore methods on Guam (see Study F-1, Job 2). NS = Not significant (P > .025).

Method	Mean CPUE's for Region 1 $\bar{x}\pm$(SD)	N	Region 2 $\bar{x}\pm$(SD)	N	Region 3 $\bar{x}\pm$(SD)	N	t	P
Hook and line	0.30±0.06	5	0.31±0.07	5	---	5	-0.14	NS
	0.30±0.06	5	---		0.46±0.07	5	-3.86	<.01
	---		0.31±0.07	5	0.46±0.07	5	-3.37	<.01
Cast net	0.75±0.29	5	0.65±0.32	5	---	5	0.57	NS
	0.75±0.29	5	---	5	0.92±0.33	5	-0.87	NS
	---	5	0.65±0.32	5	0.92±0.33	5	-1.36	NS
Gill net	1.51±0.83	5	1.32±0.94	5	---	5	0.34	NS
	1.51±0.83	5	---	5	1.33±0.80	5	0.35	NS
	---	5	1.32±0.94	5	1.33±0.80	5	-0.01	NS
Surround net	3.85±1.30	5	3.39±1.88	5	---	5	0.45	NS
	3.85±1.30	5	---	5	4.73±2.78	5	-0.64	NS
	---	5	3.39±1.88	5	4.73±2.78	5	-0.89	NS
Spear (snorkel)	1.79±1.34	5	1.73±1.11	5	---	5	0.08	NS
	1.79±1.34	5	---		1.67±0.96	5	0.17	NS
	---		1.73±1.11	5	1.67±0.96	5	0.09	NS

improperly inflate the estimated annual catch. Therefore, a separate data base was established for all such surveyed seasonal fish catches. Presently, there are a total of 30 records that include sample data of manahac (Siganus spp.) and atulai (Selar crumenapthalmus). The expansion of this data is performed only for the time period covering the seasonal harvest.

Other Data Processing Activities

Studies of Recreationally Important Reef Fish (see Study F-1, Job 8) has continued over the past year and emphasis was placed on creating data bases for important reef species. The data bases were replicated from the "inshore-catch" data base because this allowed easy transferring of historical reef fish data from the catch records. Also, the data base format permitted entry of significant biological and environmental criteria including time and location of catch, length and weight data, and weather and sea state information. Presently, there are 6288 records stored on five data bases. The data bases are for bluefin trevally (Caranx melampygus), goatfish (Mullidae), surgeonfish and parrotfish (Acanthuridae and Scaridae), atulai (Selar crumenaphthalmus), and rabbit fish (Siganidae). These data bases consist of data only collected during the inshore fisheries survey from FY 80 through FY 84. Data collected specifically for Job 8 will be entered onto the data bases at a later time.

During this fiscal year length-weight regressions were performed on the goatfish, Mulloides flavolineatus, and the rabbitfish, Siganus spinus. The HSD and DB Master statistical packages were used to perform the analysis and Visiplot was used for plotting the regression curves. However, because of the limitations of the Visiplot program, we discovered the interpretation of these graphs to be cumbersome and the regressions were eventually plotted manually (see Study F-1, Job 8).

Data collection and entry for the Pelagic Fish Feeding Study (see Study F-1, Job 9) was completed during FY 84. A data base was created and a spreadsheet design was formulated using the Visicalc software package. Three Visicalc files were established for the feeding study data. A Species File contains equations for determining frequencies of occurrence and relative importance values for all the diet categories found in each sampled pelagic fish species. A Monthly File utilizes the same equations as the Species File but relates the feeding habits of the sampled fish species on a monthly basis rather than on diet category. A Size Class File, again, uses the same equations as the other two files but relates the feeding habits of each species based upon their size class. By obtaining the necessary information from the feeding study data base, the total number and weight of each diet category is manually input into the Visicalc files. The program then calculates the frequency of occurrence by number and weight and a relative importance value for each diet category.

The Guam Fishery Species Codes data base, used for coding species in the inshore and offshore surveys, was updated over the past fiscal year to include marine invertebrates. The total number of records in this data file now stands at 1288.

RECOMMENDATION

Offshore fisheries survey data input and analysis progressed at an exceptional rate in FY 84 compared to previous years. The remaining historical offshore and inshore data should be entered onto computer files and, in order to obtain the most reliable harvest estimates for the inshore data, every effort should be made to collaborate with NMFS personnel to create a valid inshore expansion program. Fisheries survey data collection and entry should be maintained at the present level with current data being forwarded to the WPACFIN in Honolulu on a quarterly basis.

With the recreation of the Recreationally Important Reef Fish data bases, reporting procedures and detailed biological analysis of selected species can be fine-tuned. Data transfer from the "inshore-catch" data bases to the important reef fish data bases should continue, as should the entry of reef fish data collected specifically as part of Job 8.

The file management and statistical packages on hand are adequate to perform the primary objectives of Job 3. However, more sophisticated biological analysis of fisheries survey and other research data may be desired in the future. Therefore, efforts should be made to continue upgrading the DAWR software library.

Report prepared by: Robert D. Rinehart

JOB PROGRESS REPORT
RESEARCH PROGRESS SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 8

JOB TITLE: Studies of Recreationally-Important Reef Fish

PERIOD COVERED: October 1, 1983 - September 30, 1984

SUMMARY

Inshore creel survey data for FY 80-84 were reviewed and based on harvest the following species were identified as the most recreationally-important reef fish on Guam: Acanthurus triostegus, Caranx melampygus, Mulloides flavolineatus, Selar crumenopthalmus and Siganus spinus. Only S. spinus and M. flavolineatus are addressed in this study. Both species were harvested throughout the year as adults and subadults, and seasonally as juveniles. S. spinus comprised about 9% of the total surveyed harvest, and M. flavolineatus about 4.5%. The major harvests of adult fish occurred during February (21% total catch) and March (26% total catch) for S. spinus, and September (19% total catch) and December (23% total catch) for M. flavolineatus. Major juvenile runs of S. spinus occurred during April and May. Newly recruited juvenile M. flavolineatus appeared to be abundant on the reefs from March through July. Catching fish with surround nets was the most efficient harvest technique for both S. spinus and M. flavolineatus in terms of kilograms of fish taken per gear-hour. However, the most frequently employed fishing method for both species was cast netting. Although new recruits were caught exclusively with fine-meshed cast nets or drag nets, no individual fishing method appeared to target only adults or subadults of either species. In terms of average weight, the largest individual S. spinus were harvested with gill nets, while the largest M. flavolineatus were harvested with spears.

BACKGROUND

Initially, this Job was divided into two parts. The first part was begun during FY 82 and completed during FY 83. Results of that part were summarized in the annual reports for those years. The second portion was begun during FY 82 but work was suspended that same year because of competing work priorities due to a reduction in staff. In March 1984, a fisheries biologist was hired to continue working on the second portion of this study.

The second portion of Job 8 involves biology and life history aspects of selected recreationally-important reef fish species. Traditionally, among the more important inshore species in the Guam fishery are: Siganus spinus

(Siganidae), Mulloides flavolineatus (Mullidae), and Caranx melampygus (Carangidae). Culturally, these species are highly desirable both as juveniles and adults, so their stocks must sustain considerable levels of fishing pressure. In addition to reliable data on fishing participation, effort and harvest, proper management of a fishery requires pertinent biological knowledge of important food and sport fish species. Such information may be used to form the basis for sound management decisions in the maintenance or improvement of the quality of fishing on Guam, and to provide requisite data in support of government policy and laws which relate to fish and fishing.

OBJECTIVES

The objective of this Job is to identify Guam's five most recreationally-important reef fish species and to research aspects of their biology and life histories.

PROCEDURE

Computerized summaries of inshore fisheries survey data for FY 80 through FY 84 were generated (see Study F-1, Job 3). These were reviewed for information on catch including date, length, weight, total number, total weight and fishing method for each species recorded. From these summaries it was possible to identify the inshore species which received the greatest fishing pressure based on total catch by weight (kg) and number of fish.

Two of the five most heavily fished species, Siganus spinus and Mulloides flavolineatus, are addressed in this report. Data on each species were examined separately. Inshore survey data were analyzed by month and fishing method for percent of total harvest, catch rate, monthly length frequency, and length-weight relationships.

A continued literature search provided additional information on the biology and ecology of the selected important species, as well as their close relatives. Field observations made during the FY 84 contributed supplemental information to the data base.

RESULTS

According to the FY 80 through FY 84 data base, the five most heavily fished inshore species at Guam include the following: Acanthurus triostequs (kichu); Caranx melampygus (ee, tarakito); Mulloides flavolineatus (tiao, salmonette); Selar crumenopthalmus (atulai) and Siganus spinus (manahac, sesjun). These species, with the exception of S. crumenopthalmus, are commonly found and harvested on shallow reef flats. S. crumenopthalmus, on the other hand, is commonly harvested from deeper lagoons, embayments and larger channels, as well as from offshore reefs and banks. The harvests of these species occur through the use of hook and line, cast net (talaya), gill net (tekin), surround net (chichulon umesugon) and spear, the five primary types of inshore fishing gear employed at Guam (see Study F-1, Job 2).

Siganus spinus (Siganidae)

Siganus spinus, commonly called the scribbled rabbitfish or sesjun, are harvested at Guam throughout the year as adults and subadults, and also seasonally as juveniles (manahac hatang). Peak juvenile recruitment occurs on shallow reef flats primarily between April and June, and secondarily around October. However, limited recruitment may occur throughout the year. Major recruitment runs usually occur a few days before or after the last quarter moon (locally called Quarto Menquate). The amount of manahac that is harvested from year to year fluctuates widely, largely as a result of the highly variable nature of these major recruitment runs (Kami and Ikehara, 1976).

Harvest

Over the last five year period, subadult and adult S. spinus comprised about 9% of the total surveyed inshore harvest. Monthly harvests peaked at two time periods in the year. The major harvests occurred during February (21% of total catch) and March (26% of total catch) with a secondary increase in catch around August (12.8% of total catch).

During the period encompassing May through July, the S. spinus harvest appears to drop to approximately 5% of the total harvest for that interval. However, it should be noted that these figures are not representative of the harvest of newly recruiting juveniles (manahac hatang) which are usually taken sporadically, sometimes in very great numbers, on a few days during April and May.

Length Frequency

Juvenile S. spinus (manahac hatang) recruit at an average size of approximately 43 mm fork length (FL), but are harvested between 39 and 60 mm FL. Between 60 and 100 mm FL, they are nearly absent from our catch records. During the time spent within this size range these fish change from plankton feeders to consumers of reef-associated benthic algae. During this period they are relatively undesirable to fishermen as food, and at that stage are known locally as "dage".

During all months of the year the size of S. spinus most frequently harvested ranged in fork length from 100-160 mm. The highest percentages of larger individuals (> 200 mm FL) were harvested during February, March and November, but occasional catches of larger fish were recorded throughout the year. Figure 1 shows the combined five-year length frequency data for S. spinus sampled during each month of the year.

While no single primary inshore fishing method consistently targeted a specific size of S. spinus, new recruits were caught exclusively with special fine-meshed cast nets or drag nets. The widest size ranges of S. spinus (63-350 mm FL and 66-300 mm FL) were harvested with hook and line and spear, respectively (Table 1). The narrowest size range (36-230 mm FL) was caught with surround nets.

However, in terms of average weight, the largest individuals were caught with gill nets (75.0g) and cast nets (73.43g). The average size of S.

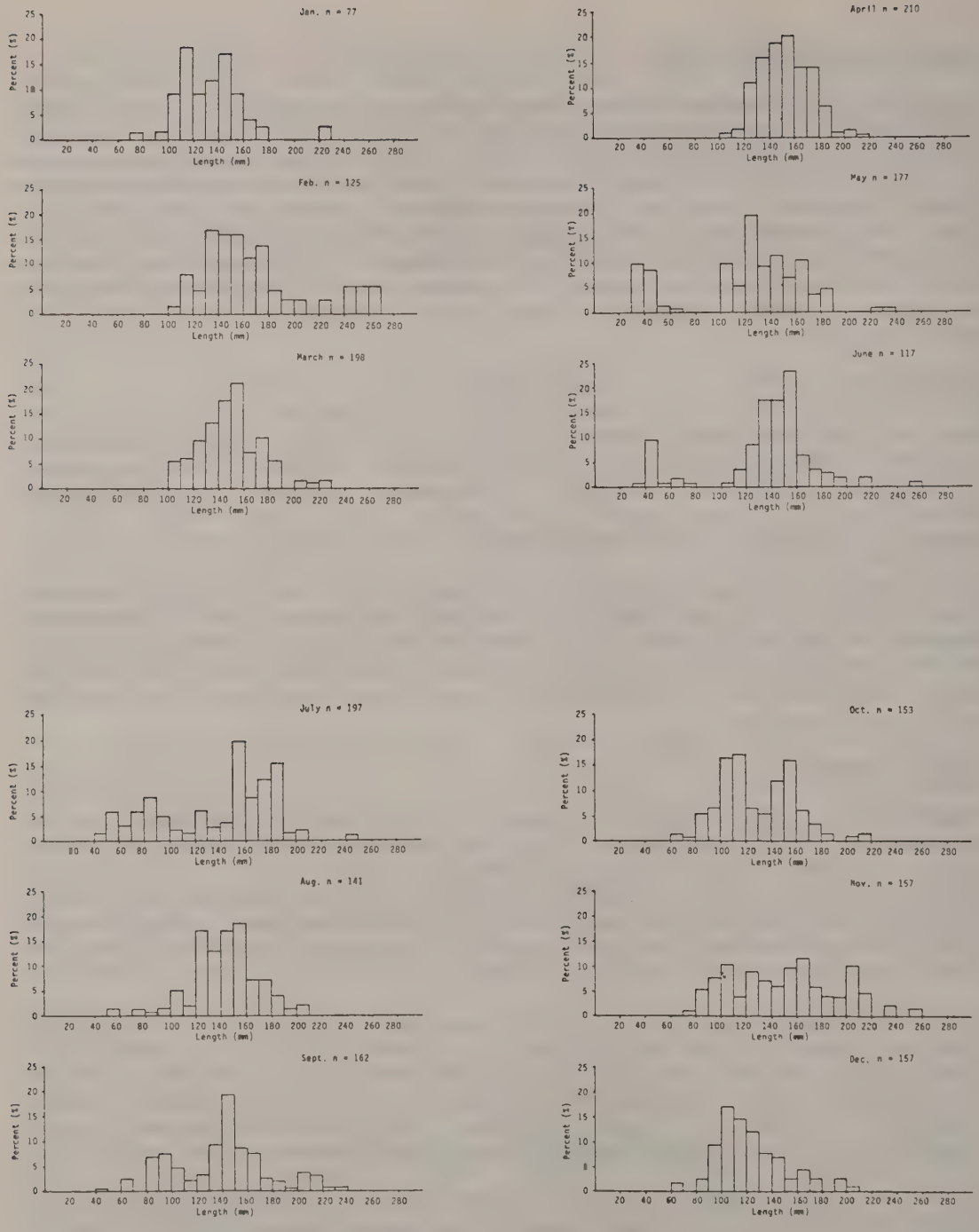


Figure 1. S. spinus combined (by month) FY 80-84 length-weight frequency data.

spinus caught with hook and line was slightly heavier (69.84g) than the average individual taken with surround nets (65.00g). The average weight for S. spinus caught by spear was not calculated since the sample size (n=5) was too small to obtain an accurate value.

Among the inshore fishing trips sampled over the last five years in which S. spinus was caught, the approximate frequencies of occurrence of each gear type employed were as follows: cast net, 46%; hook and line, 20%; gill net 17%; surround net 14%; and spear with snorkel 3%. The most efficient annual catch rate for S. spinus, in terms of kilograms of fish caught per gear-hour of fishing effort (Kg/G-H) was attained through the use of surround nets, at 0.53 Kg/G-H (Table 2). The highest monthly catch rate for S. spinus was also attributed to surround netting and occurred around March at 1.87 Kg/G-H.

For all fishing methods combined, the catch rate for S. spinus peaked at approximately 0.20 Kg/G-H in March (Table 2). Sampled cast net harvests generally peaked in February, while surround net harvests peaked in March. Hook and line fishing for S. spinus appeared to be important from December through April, with a peak in April.

S. spinus between 40-100 mm fork length were caught primarily by cast nets and gill nets. Individuals larger than 100 mm fork length were caught by all gear types. Although, surround net harvests of S. spinus longer than 230 mm FL are not recorded in the inshore survey data, fish up to 300 mm FL and longer are known to have been caught by this method (personal observation). The largest individual S. spinus recorded in the inshore survey data base (350 mm FL) was caught by hook and line.

Figure 2 shows the regression line plotted for the length-weight relationship of S. spinus. The relationship is non-linear. Data points are natural log transformations of actual numbers. Regression analysis is as described in Sokal and Rohlf, 1969.

Mulloides flavolineatus (Mullidae)

Mulloides flavolineatus, commonly called the yellow-lined goatfish, are harvested as juveniles (tiao), sub-adults and adults (salmonette) throughout the year. Newly recruiting juveniles known locally as "Santa Maria Tiao", usually begin to appear in larger numbers around the month of March. The harvest of this species generally increases from April through July, and may peak 2 or 3 times a year. Adults are caught in low numbers with no apparent seasonal increases.

Harvest

Catches of M. flavolineatus over the past five-year period represented 4.53% of the total surveyed harvest. Major peaks in the surveyed harvest of adult M. flavolineatus occurred in December (23.19% of total catch) and September (19.44% of total catch). A smaller peak occurred during June, (7.31%, of total catch).

Cast netting (46.89%) was the most frequently recorded catch method. The frequency of occurrence of other methods were recorded as follows: gill

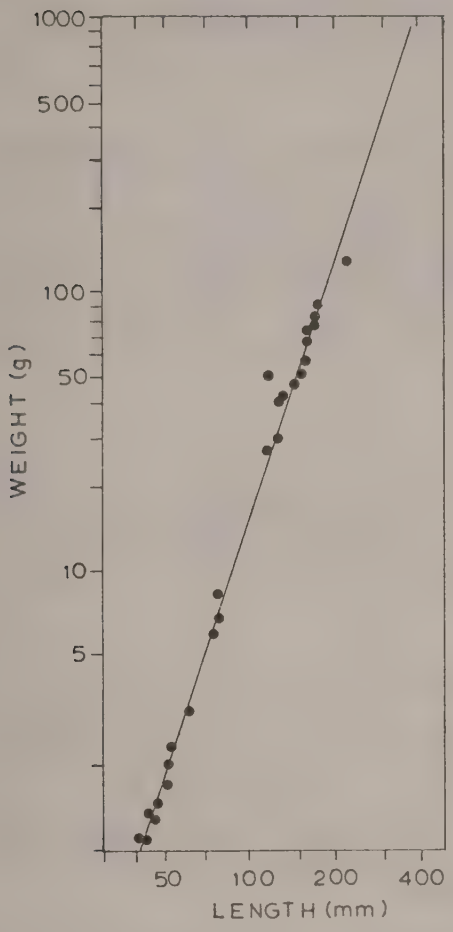
Table 1. Size ranges of Siganus spinus caught through the use of Guam's five primary inshore fishing methods.

Method	Fork Length (mm) range	mean	Mean Weight (g)
Hook and Line Fishing	63-350	148.2	69.84
Cast Netting	39-250	139.7	72.43
Gill Netting	59-260	134.8	75.00
Surround Netting	36-230	147.0	65.00
Spearing*	66-300	153.4	**

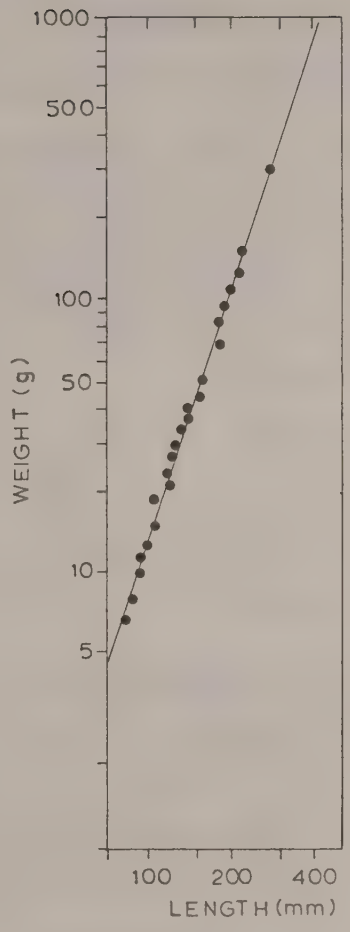
*Spear with snorkel gear only.
**Small sample size prohibits calculation.

Table 2. Siganus spinus catch rates by inshore fishing method based on combined FY 80-84 Guam inshore fisheries survey data. Kg/GH = kilograms harvested per gear-hour of fishing effort.

	Fishing Method					
Month	Hook and Line (Kg/GH)	Cast Net (Kg/GH)	Gill Net (Kg/GH)	Surround Net (Kg/GH)	Spear with Snorkel (Kg/GH)	All Months (Kg/GH)
Jan	0.02	0.06	0.43	0.55	0.02	0.04
Feb	0.01	0.33	0.51	0.36	0.77	0.16
Mar	0.04	0.13	0.01	1.87	-	0.20
Apr	0.03	0.10	0.03	0.32	-	0.13
May	0.01	0.02	0.79	0.10	0.01	0.03
Jun	0.01	0.04	0.01	0.18	-	0.02
Jul	0.01	0.06	-	-	-	0.01
Aug	0.01	0.06	0.10	1.03	0.01	0.04
Sep	0.01	0.09	-	0.95	0.01	0.01
Oct	0.01	0.05	0.01	0.66	0.01	0.02
Nov	0.01	0.06	0.03	0.49	-	0.01
Dec	0.20	0.06	0.03	-	-	0.03
ALL MONTHS	0.01	0.07	0.03	0.53	0.04	0.04



S. spinus



M. flavolineatus

Figure 2. Regression line plot for the length-weight relationship of S. spinus and M. flavolineatus.

netting (33.33%), spearing (18.30%) surround netting (12.45%) and hook and line fishing (3.30%). The greatest percentages of total harvest were taken with cast nets (12.72%) and gill nets (7.77%). The most efficient annual catch rate for M. flavolineatus was attained through the use of surround nets, at 0.15 Kg/G-H (Table 3). The highest monthly catch rate recorded for M. flavolineatus occurred in September (1.61 Kg/G-H) and was also obtained through the use of surround nets.

For all fishing methods combined, peaks in catch rate for M. flavolineatus occurred twice during the year at 0.06 Kg/G-H in a two-month period from December through January and in May (0.05 Kg/G-H) (Table 3). Surround net harvests were important in summer and fall months with a peak in September. The highest catch rate for cast netting occurred in January. Gill netting for M. flavolineatus was most efficient in January, and again during September and October. Hook and line fishing was important from late summer (August) through January. The greatest spearing catch occurred in February.

Length Frequency

Throughout the year the size range of M. flavolineatus most heavily harvested is 80-110 mm FL. Fish larger than 140 mm FL are recorded in the catch sporadically during the year, but primarily between January and May. Figure 3 presents the length frequency distribution by month for sampled M. flavolineatus.

The range of M. flavolineatus fork length recorded in the FY 80-84 inshore creel survey data base was 62-400 mm. The 400 mm FL record exceeds the length extreme of 340 mm FL reported by the United Nations Food and Agriculture Organization for the Eastern Indian Ocean and Western Central Pacific. The size range and average size of M. flavolineatus caught through the use of Guam's five primary inshore fishing methods overlap considerably (Table 4). However, on the average the smallest-sized individuals (99.5 mm FL) were caught with cast nets, and the largest-sized fish (218.0 mm FL) were harvested with spears.

Gill nets and surround nets appear to be the least size-selective of the five primary inshore fishing methods. Surround nets harvested the widest size range of M. flavolineatus (89-400 mm FL). Cast netting generally excluded individuals larger than 180 mm. In addition, cast nets were often employed along the shoreline where only smaller individuals are found. The method of spearing appears to exclude fish smaller than 130 mm. However, since the sample size for this method is so small (n=5), a general statement about the selectivity of this method cannot be made at this time. Hook and line was responsible for harvesting individuals between 80 and 180 mm FL. Although 180 mm FL is the largest size of M. flavolineatus recorded in our hook and line data base, it is possible that individuals larger than this may be caught with this type of fishing gear.

Figure 2 is a regression line plot of the length/weight relationship for M. flavolineatus. The relationship is non-linear. Data points are natural log transformations of actual numbers. Regression analysis is as described in Sokal and Rohlf, 1969.

Table 3. Mulloides flavolineatus catch rates by inshore fishing method for combined FY 80-84 Guam inshore fisheries survey data. Kg/GH = kilograms harvested per gear-hour of fishing effort.

	Fishing Method					
Month	Hook and Line (Kg/GH)	Cast Net (Kg/GH)	Gill Net (Kg/GH)	Surround Net (Kg/GH)	Spear with Snorkel (Kg/GH)	All Months (Kg/GH)
Jan	0.01	0.36	0.18	-	-	0.06
Feb	-	0.01	0.03	-	0.08	0.01
Mar	-	0.03	0.04	-	-	0.03
Apr	-	-	0.02	-	-	0.03
May	-	0.08	0.03	0.26	0.01	0.05
Jun	-	0.04	0.04	0.32	-	0.04
Jul	-	0.03	0.02	0.27	-	0.03
Aug	0.01	0.04	0.10	-	0.01	0.02
Sep	0.01	0.05	0.14	1.61	-	0.03
Oct	-	0.04	0.14	-	-	0.01
Nov	0.01	0.02	0.03	0.29	-	0.01
Dec	0.01	0.14	-	-		0.06
ALL MONTHS	0.01	0.06	0.06	0.15	0.01	0.02

Table 4. Size ranges of M. flavolineatus caught through the use of Guam's five primary inshore fishing methods.

Method	Fork Length (mm) Range	Mean	Mean Weight (g)
Hook and Line Fishing	87-260	132.5	53.2
Cast Netting	62-255	99.5	12.0
Gill Netting	82-330	161.1	81.4
Surround Netting	89-400	155.9	76.6
Spearing*	130-315	218.0	124.9

*Spearing with snorkel gear only

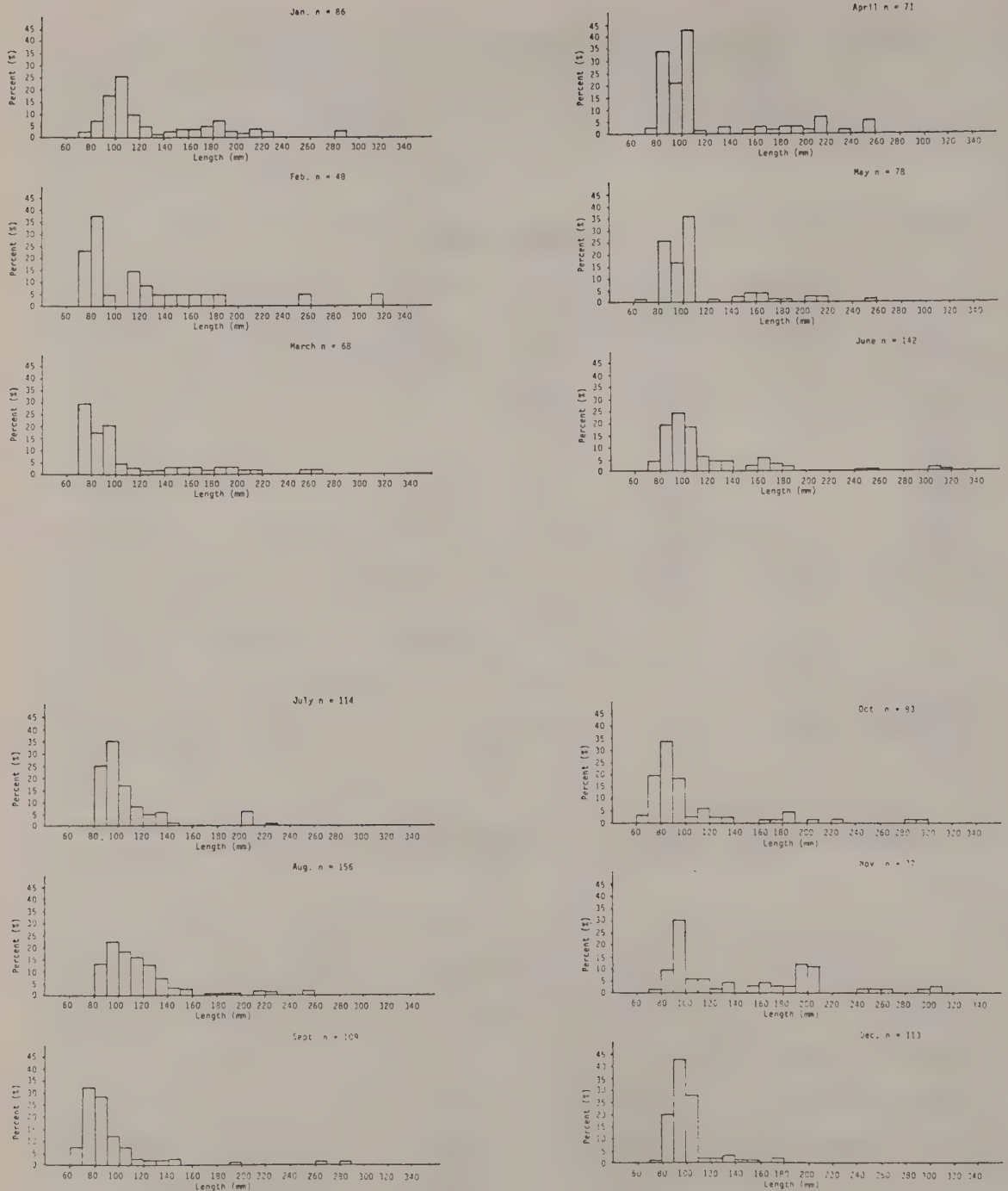


Figure 3. M. flavolineatus combined (by month) FY 80-84 length-weight frequency data.

RECOMMENDATIONS

Studies of the biology and life history of Guam's recreationally-important species of reef fish should be continued. Specific attention should be given to collecting and analyzing data on gonad development and reproductive maturity. These and other life history attributes should be investigated in order to broaden the existing data base for these species for the purpose of long-range management, should such a course of action become desirable.

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Report prepared by: Gretchen R. Grimm

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: F
STUDY NO.: F-1
JOB NO.: 9

JOB TITLE: Pelagic Fish Feeding Study

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Between December 1981 and July 1983, the contents of 1314 stomachs from five species of pelagic gamefishes (wahoo, skipjack tuna, yellowfin tuna, blue marlin, and mahimahi) landed at Guam were analyzed.

Fishes, primarily medium to large epipelagic species, formed the bulk of the diet of all five gamefishes. Epipelagic squids were nearly as important as fishes in the diet of skipjack tuna, and significantly important in the diets of yellowfin tuna, blue marlin, and mahimahi.

Mesopelagic crustaceans and fishes were important in the diet of yellowfin tuna; and the epipelagic young of demersal crustaceans were important in the diet of skipjack tuna. Epipelagic young of demersal fishes formed a small but consistent and significant portion of the diets of all five gamefishes, forming an important link between coastal and oceanic habitats. It was not possible to assess the direct effects of Fish Aggregating Devices (FADs) on the diets of these gamefishes, but important prey species were consistently observed, often in large numbers, in the vicinities of FADs.

BACKGROUND

Numerous studies have indicated that tunas (Scombridae), mahimahi (Coryphaenidae) and billfishes (Istiophoridae) are opportunistic feeders that consume wide varieties of pelagic organisms. When in coastal waters, substantial portions of their diets may consist of juvenile or larval stages of inshore fishes. Stomachs of blue marlin, yellowfin tuna, and wahoo collected at Guam during recent annual Marianas Fishing Derbies were found to contain primarily fishes, of which many were late larval or juvenile stages of reef-dwelling species. Some of these juvenile fishes were similar or identical to those species observed around Guam's FADs. Very little is known about the ecological relationships between reef fish populations and the pelagic migratory species that support the bulk of Guam's recreational trolling fishery.

OBJECTIVES

1. To broaden the life history information base on Guam's reef and pelagic fish species as an aid in assessing the status of their populations for proper management purposes.

2. To determine the feeding habits of Guam's recreationally-important, pelagic fish which are associated with FAD's, and to identify any feeding changes that may possibly have been incurred by this association.

3. To assess the importance of Guam's reef fish in providing forage for recreationally-important pelagic fish.

PROCEDURES

Collection and Preservation

A total of 1314 stomachs from five important pelagic gamefish species were sampled between December 1981 and July 1983 (Table 1). Most of the stomachs were purchased under contract from the Guam Fishermen's Cooperative. All samples were obtained from fishes caught by surface trolling with artificial lures. A wide range of sizes of each species were obtained (Table 2), but it was not always possible to obtain samples of all species during all months of the study.

For each sample, the stomach and if possible, the gonads, were removed and sealed in a plastic bag which contained an identification number. The species name, fork length, weight, area caught (if known), date caught, and date of removal were recorded. An effort was made to remove the stomach the same day the fish was caught, but this was not always possible.

Examination of Stomach Contents

Dietary items were sorted to the finest recognizable taxonomic unit, counted, then weighed to the nearest 0.1g. The degree of digestion was estimated for each prey species and the lengths of certain prey species were measured to the nearest millimeter. Selected prey items were fixed in 10% formalin, then preserved in 70% ethanol for later identification or for comparison with contents from other stomachs. Many well-digest remains of fishes and cephalopods that could not be readily placed into family or ordinal-level groups were lumped as "unidentified".

Analysis of Data

Frequency of occurrence, numerical abundance, and percent by weight were measured for all prey items identified to the finest taxonomic unit possible. An index of relative importance (IRI; Pinkas et al., 1971) and percent by weight were calculated at the family level for fishes, and the ordinal level for mollusks and crustaceans to facilitate comparisons with other studies of the diets of pelagic gamefishes.

Table 1. Monthly stomach content sample sizes of recreationally-important pelagic gamefish species from Guam.

Species	Month 1981 D	J	F	M	A	1982 M	J	J	A	S	O	N	D	1983 May	July	Total
Wahoo	18	32	14	16	11	12	9	23	5	18	16	35	15	7	8	239
Skipjack Tuna	18	13	18	14	30	41	32	10	46	22	24	36	28	-	-	322
Yellowfin Tuna	7	22	8	3	5	40	19	59	29	26	36	7	24	-	3	288
Blue Marlin	-	-	-	3	3	7	25	21	5	6	6	2	-	1*	9	88
Mahimahi	11	62	56	114	42	24	2	12	1	3	2	18	14	12	4	377
TOTAL	54	129	96	150	91	124	87	125	86	75	84	98	71	20	24	1,314

*In Feb., not May

Table 2. Size distribution of recreationally-important pelagic gamefish species from Guam sampled for stomach content analysis.

Species	Size in cm FL 40	50	60	70	80	90	100	110	120	130	140	150	200	250	300
Wahoo			1	9	24	44	50	50	36	19	6				
Skipjack Tuna	20	167	72	55	8										
Yellowfin Tuna	3	29	47	63	52	25	37	19	10		2	2			
Blue Marlin												1	59	21	7
Mahimahi			19	117	116	66	41	16	1	1					

To test for differences in food habits between species, a G-Test was applied to a two-way, RxC, contingency table where R is the number of prey species, C is the number of predator species, and each cell contains the total number of prey of the ith prey category found in the stomach of the jth predator (Crow, 1981; Sokal and Rohlf, 1981).

To identify possible competitive interactions, proportional diet overlaps (P) between predator species x and y, based on proportional weights of prey categories, were calculated by the formula:

$$P_{xy} = 1-.5\ (\lesssim|P_{xi} - P_{yi}|)\ \text{(Hurlbert, 1968)}$$

The least value for each diet category is summed to obtain the measure P for a given predator pair. Theoretical values range from zero in diets that are entirely different to 1.0 for those that are identical.

In order to ascertain the importance of trophic interactions between marine habitats, the diets of the five pelagic gamefishes studied were apportioned into broad functional groups based on the habitat in which a given prey taxa spends the bulk of its life. Therefore, prey taxa were assigned to demersal, epipelagic or mesopelagic habitats, and their diet weights (the percent by weight of a prey taxa in the diet of its predator) within each habitat group were summed. For example, diet weights of pelagic larvae or juveniles of reef fishes, stomatopods, or most decopod crustacea were assigned to the demersal habitat and those of species believed to spend most of their time below the mixed layer, such as myctophids and crimson euphausids, were assigned to the mesopelagic habitat.

Prey that could not be assigned to one of these three habitats were lumped into "unplaceable" categories of fishes, mollusks or crustaceans. The "unplaceable" categories are independent of the "unidentified" categories of the taxonomic breakdown. For example, certain mesopelagic fishes could not be identified to the family level and were therefore considered "unidentified" in the taxonomic breakdown (Figure 1 and in species accounts of text), but were placed in the mesopelagic functional group. Percentages by weight contributed by each of the functional habitat groups to the diet of each predator species were then compared.

Seasonality of prey taxa in diets was examined by comparing monthly diet composition by weight of selected prey taxa during a 13-month period of continuous sampling. Changes in diet with growth were determined by comparing diet composition by weight between size classes.

RESULTS

Diet composition as percent occurrence, percent abundance, and percent weight for the five pelagic gamefishes are shown in Figure 1. A wide size-range of organisms was consumed by each of the predators. This resulted in smaller-sized organisms, relatively unimportant in biomass, far overshadowing larger organisms in numbers and frequency of occurrence. Since the index of relative importance (IRI; Pinkas et al., 1971) places a greater emphasis on the parameters of numbers and frequency than on weight, it was judged to be a less definitive method for measuring the diets of the types of gamefishes studied. In contrast, a more appropriate single

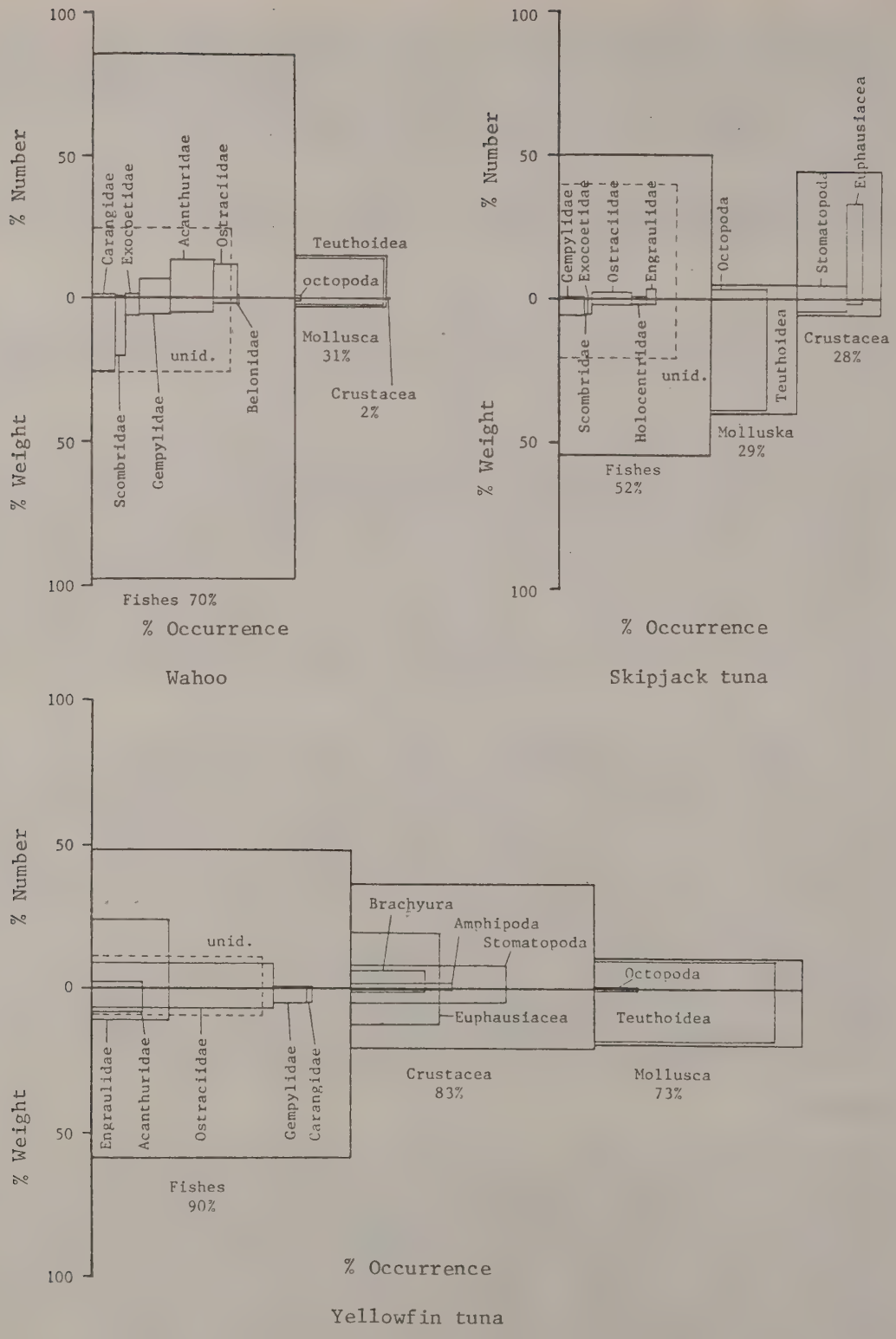
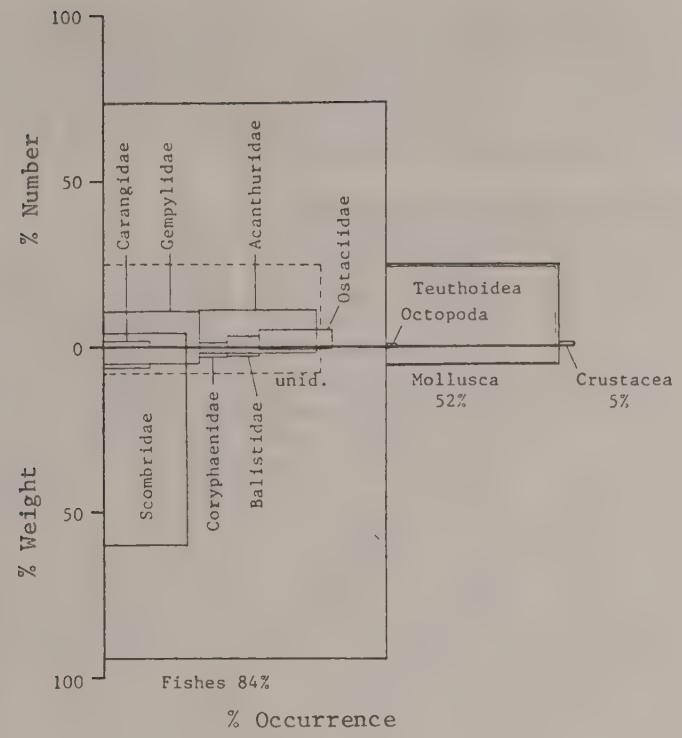
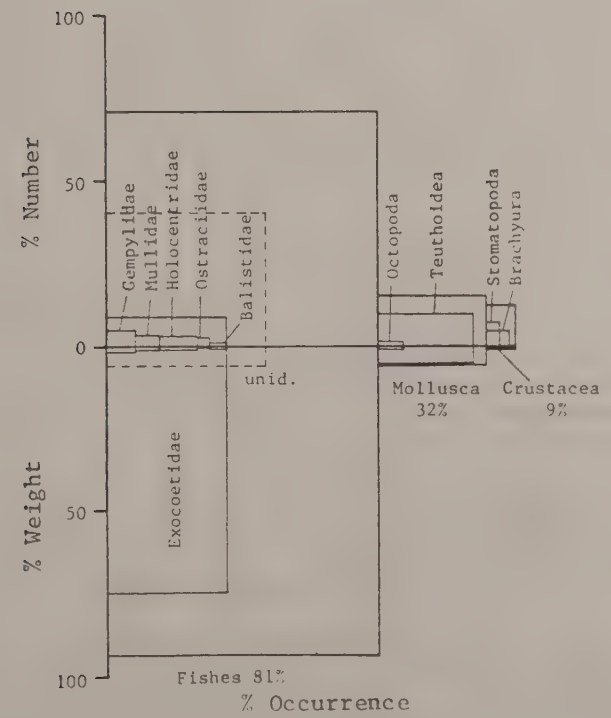


Figure 1. Percent composition of major food categories in number, weight, and frequency of occurrence for five principal species of pelagic gamefishes from the vicinity of Guam.



Blue Marlin



Mahimahi

Figure 1. (cont)

measure of diet composition for the species studied was judged to be the weight of prey organisms consumed, as compared in Table 3.

The diets of each of the five gamefishes species are summarized below, followed by a discussion of the results.

Wahoo (Acanthocybium solandri):

Seventy-four percent of the 239 stomachs sampled contained food. Prey consisted primarily of fishes (94.4% by weight and occurring in 94.9% of the stomachs containing food) and to a minor extent, of cephalopods (2.5% by weight; Table 3; Figure 1). The few crustacea present (2.9% of the stomachs) were negligible in terms of their weight contribution and most likely originated in the stomachs of prey fishes. Twenty-one families of fishes were preyed upon, the most important by weight being: Carangidae, Scombridae, Exocoetidae, Gempylidae and Acanthuridae, which collectively comprised over 89% of the biomass of identifiable fishes. Relatively large prey, which were frequently cut into large pieces, accounted for the bulk of the diet (eg. carangids and scombrids alone accounted for 67% of the identifiable fishes). Representative species, Decapterus macrosoma, Elagatis bipinnulatus, and Katsuwonus pelamis, belong to the fast-swimming epipelagic community. A notable feature of the wahoo's diet was the advanced state of digestion of much of its prey which made identification difficult. This resulted in a considerable amount of relatively large prey being lumped into the "unidentified fishes" category (21.8% of its diet by weight). The remaining fish in the wahoo diet consisted of smaller epipelagic species (eg. exocoetids and belonids), or the young of a wide variety of epipelagic or demersal fishes (eg. gempylids, molids, acanthurids, balistids and ostraciontids). Squid occurred frequently and ranked high in IRI, but their biomass was slight. This was due to the frequent occurrence of digestive-resistant beaks and eyes which seemed easily retained among the folds of the stomach wall. Partially digested, recently ingested squid occurred infrequently.

Skipjack Tuna (Katsuwonus pelamis):

Sixty-five percent of the 322 stomachs sampled contained food. Prey consisted primarily of fishes (53.9% by weight) and cephalopods (39.6%), and to a lesser extent, of crustacea (6.3%, Table 3; Figure 1). Fishes occurred more frequently, were more abundant, and weighed more than all other prey combined. Nineteen families of fishes were preyed upon, the most important in terms of weight being Gempylidae (5.6%), Scombridae (exclusively K. pelamis, 5.4%), Exocoetidae (5.3%), and Hemiramphidae (4.2%). All but K. pelamis ranked relatively high in IRI because they occurred relatively frequently or in large numbers. The single most important prey fish were young snake mackerels, Gempylus serpens.

Mollusks, particularly small ommastrephid squid (usually under 100 mm mantle length), were nearly as important as fishes (39.8% by weight). Symplectotenthis sp. cf. oualaniensis comprised 80% of the molluscan component of the diet while another ommastrephid, (Hyaloteuthis pelagica), and paper nautili, (Argonauta spp.) were relatively minor

Table 3. Selected food categories and ecological groups of pelagic gamefishes collected in the vicinity of Guam. Only taxa comprising > 1% of the diet of a given species are shown. A + indicates presences of a given taxa at < 0.1%. Figures are rounded to the nearest 0.1%.

	% Weight				
Prey	Wahoo	Skipjack Tuna	Yellowfin Tuna	Blue Marlin	Mahimahi
Fishes	94.9	53.9	58.9	94.0	93.0
Epipelagic	61.7	27.9	36.6	76.3	81.6
Engraulidae	.7	2.0	11.2		.1
Exocoetidae	6.1	5.3	4.0	.5	74.5
Belonidae	1.8	.6		.4	.3
Hemiramphidae		4.2	.7	+	2.0
Carangidae	23.1	1.1	4.8	3.2	.7
Coryphaenidae	.8		1.3	3.3	.7
Gempylidae	5.7	5.6	5.2	5.1	2.3
Scombridae	23.5	5.4	1.0	59.9	.3
Ostraciontidae	1.7	2.5	6.8	.3	.1
Tetraodontidae	1.1		.1	2.5	.3
Molidae	.9	1.2	.1	.5	
Other	.2	+	1.3	.6	.3
Demersal[4]	14.0	5.1	12.2	9.4	4.1
Holocentridae	.7	2.1	1.1	.3	.9
Carangidae	2.2		.1	3.3	
Mullidae		.6		.1	1.3
Acanthuridae	4.4	1.1	7.4	2.2	.4
Balistidae	1.5	.7	1.1	3.0	.5
Other	1.3	.6	2.5	.5	1.0
Mesopelagic Fishes[6]	.3	+	3.7	.6	.5
Unplaceable	21.6	20.8	6.4	7.7	6.8
Mollusca	2.5	39.6	19.0	6.0	6.3
Epipelagic	.7	36.2	13.4	4.6	5.1
Teuthoidea	.4	35.3	12.1	4.4	3.8
Octopoda	.4	.7	1.2	.2	.4
Other		.2	+	+	+
Unplaceable Teuthoidea	1.8	3.6	5.6	1.4	1.2
Crustacea	+	6.3	20.5		.7
Epipelagic (Amphipoda)		.1	.4	+	+
Demersal	+	4.3	7.0	+	.7
Stomatopoda larvae	+	4.0	5.1	+	.6
Brachyuran larvae	+	.2	1.2	+	.2
Other			.7		
Mesopelagic		1.7	12.4		+
Euphansiacea		1.7	12.4		+
Unplaceable	+	.2	.6		+
Tunicata-(Epipelagic)		+	1.6		
Ecological Groups:					
Epipelagic	62.4	64.2	52.0	80.9	86.7
Demersal	14.0	9.4	19.2	9.4	4.8
Mesopelagic	.3	1.7	16.1	.6	.5
Unplaceable	23.4	24.6	12.6	9.1	8.0

[1]
[2]Excludes certain bottom-associated species, e.g. Caranx and Carangoides spp.
[3]Only Lactoria diaphanus; others considered demersal.
[4]Only Lagocephalus lagocephalus; others considered demersal.
[5]Excludes Decapterus spp, Selar crumenophthalmus and Elagatis bipinnulatus.
[6]Nearly all included in "unid. fishes" category in Tables 3 - 7.

components. Crustacea comprised only 6.3% of the diet in terms of weight, but were small, and nearly as abundant as fishes. Larval and pre-settlement stage stomatopods comprised the bulk of the biomass of crustacea in the diet (63%) while small, white euphausids were most abundant (76% by number). Pelagic amphipods and larval decopods were of minor importance, as was the pelagic tunicate, Pyrosoma sp.

Yellowfin Tuna (Thunnus albacares):

Ninety-eight percent of the 288 stomachs sampled contained food. Prey consisted primarily of fishes (58.9% weight) with the remainder nearly equally divided between mollusks (19.0%) and crustaceans (20.5%; Table 3; Figure 1). Fishes occurred more frequently and in greater numbers than did either mollusks or crustaceans. Thirty-one families were preyed upon, the most important in terms of weight being Engraulidae (11.2%), Acanthuridae (7.4%), Ostraciontidae (6.9%), Gempylidae (5.2%), and Carangidae (4.9%). The single most important fish prey were anchovies, (Stolephorous spp., primarily S. punctifer). Other important epipelagic prey species were Lactoria diaphanus, Gempylus serpens, and Decapterus macrosoma. Juvenile billfish (Makaira nigricans and Xiphias gladius) and tuna (K. pelamis) were also occasionally eaten. Crustaceans contributed slightly more to the weight of the yellowfin diet than did mollusks, and occurred more frequently and in greater numbers. The bulk of the crustaceans were unidentified crimson mesopelagic euphausids. The remainder consisted primarily of the early stages of demersal species, mainly stomatopods and decopods, and to a lesser extent, of epipelagic amphipods. The bulk of the mollusks consumed were cephalopods, primarily the ommastrephid squids, Symplectoteuthis sp. cf. oualaniensis and Hyaloteuthis pelagica, and to a minor extent, paper nautili, Argonauta spp.

Blue Marlin (Makaira nigricans):

Eighty-eight percent of the 88 stomachs sampled contained food. Prey consisted almost entirely of fishes (94.0% by weight) and to a minor extent, of cephalopods (Table 3; Figure 1). Traces of crustacean remains, primarily stomatopods, probably originated in the stomachs of prey fishes. The most important prey of the marlin sampled were tuna (59.9% by weight; highest in IRI), particularly skipjack tuna(Katsuwonus pelamis) and small yellowfin tuna (Thunnus albacares). Most of the remainder of prey fishes were epipelagic species such as atulai (Selar crumenophthalmus), juvenile mahimahi and pompano dolphin (Coryphaena hippurus and C. equiselis), snake mackerel (Gempylus serpens), pelagic puffer (Lagocephalus lagocephalus), and juvenile blue marlin. A significant portion of the diet (9.4%; Table 3) consisted of young stages of demersal fishes such as balistids, acanthurids, and holocentrids. Over half of the marlin sampled contained squid remains, primarily beaks. Thus, squid ranked nearly as high in IRI as did tuna, although in terms of weight, they were only a tenth as important (5.8%). The only positively identified squid prey was the ommastrephid Symplectoteuthis sp. cf. oualaniensis. The octopods, Octopus sp. cf. teuthoides and Argonauta spp., comprised most of the remaining cephalopods in the diet.

Mahimahi (Coryphaena hippurus):

Eight-one percent of the 377 stomachs sampled, contained food. Prey consisted primarily of fishes (93.0% by weight); to a minor extent, of cephalopods (6.3%); and to a negligible extent, of crustacea (0.7%) (Table 3; Figure 1). Flying fishes (Exocoetidae) were unquestionably the most important prey of the mahimahi sampled (74.5% by weight). The most important of the six species that were identified were Cypselurus spilonopterus, C. angusticeps and Prognichthys sealei. Twenty-six other families of fishes were preyed upon, the most important being Gempylidae, Hemiramphidae, Mullidae, Holocentridae, Coryphaenidae, and Carangidae. Important prey species were the snake mackerel, Gempylus serpens, the halfbeaks Euleptorhamphus viridis and Oxyporhamphus micropterus, juvenile mahimahi, and post-larval goatfish, Mulloides flavolineatus. Cephalopods occurred nearly as frequently as did flying fishes, but were much less important in terms of weight (6.3%). This was due primarily to the tendency of digestive-resistant squid beaks and eyes to be retained among the folds of the stomach wall. Ommastrephid squids, primarily Symplectoteuthis sp. cf. oualaniensis, and to a minor extent, Hyaloteuthis pelagica, comprised most of the cephalopod component of the mahimahi diet. The remainder consisted primarily of paper nautili, (Argonauta spp.) Crustaceans, primarily young stomatopods and to a minor extent, larval brachyurans, were a minor component of the diet of the mahimahi sampled (0.7% by weight). They were, however, not incidental in occurrence, since on at least one occasion, a stomach was crammed full of stomatopods.

Comparisons

Several differences as well as similarities among the diets of the five gamefishes studied are apparent. All fed on a wide array of fish and molluscan prey, but only the two tuna species, skipjack and yellowfin, preyed to a significant extent on crustaceans.

Results of the G-test applied to numbers of each prey species show significant differences in diet ($P < .05$) among the five predators sampled, and that each of their diets is heterogeneous. This test, however, does not indicate where the differences lie, nor does it quantify them.

Proportional diet overlap, P, is a measure of the degree of overlap based on percent by weight of prey categories consumed among predator species. It quantifies diet but does not imply any measure of statistical probability. Mean proportional diet overlap among species, P, ranged from .24 for mahimahi to .36 for wahoo and skipjack tuna (Table 4). Mahimahi consistently had the least dietary biomass in common with other species. Among other gamefishes, the diets of skipjack tuna and yellowfin tuna were least similar to the diet of blue marlin (P = .29 and .30, respectively); but they were among the most similar when compared to each other (P = .51). Wahoo and blue marlin tended to feed on relatively large prey, with over half (P = .53) of their respective diets in common. This, and all other values of proportional overlap, are relative and liberal since differences in prey sizes within taxa are not considered, and since pooled, unidentified prey is included (accounting for 14-29% of a given P).

Table 4. Proportional diet overlaps, P_{xy}, among five recreationally-important pelagic gamefishes from the vicinity of Guam.

	Mean proportional diet overlap with other species	*K. pelamis*	*T. albacres*	*M. nigricans*	*C. hippurus*
A. solandri	.36	.34	.34	.53	.23
K. pelamis	.36	-	.51	.29	.28
T. albacares	.32	-	-	.30	.25
M. nigricans	.32	-	-	-	.20
C. hippurus	.24	-	-	-	-

Mahimahi are clearly the most specialized of the five gamefish species, preying primarily on exocoetids. Blue marlin preyed primarily on scombrids, and wahoo preyed most heavily on a variety of relatively large fishes such as carangids, scombrids and exocoetids. Skipjack and yellowfin tuna preyed heavily on squid or crustaceans, or both, as well as on fishes. The most important fish prey of skipjack were gempylids, exocoetids and scombrids whereas those of yellowfin were engraulids, ostraciontids and gempylids. Yellowfin tuna were the only predators to feed heavily on euphausids at mesopelagic depths.

Each of the five predators preyed primarily on organisms which spend their entire lives in the epipelagic habitat, and to a lesser extent, on the epipelagic young of demersal species (Table 3 ; Figure 2). Only yellowfin tuna fed to an appreciable extent on mesopelagic organisms (16% of its diet by weight), primarily euphausids.

Considerable size differences existed between similar prey in the diets of similarly-sized predators as well. Blue marlin, all of which were larger than any individuals of the other species sampled, fed on the largest prey, primarily skipjack tuna and juvenile yellowfin tuna up to 560 mm FL. Among the other four gamefish species, wahoo and mahimahi fed to a greater extent on relatively larger prey than did similarly-sized (by weight) skipjack or yellowfin tuna. Wahoo under about 10 kg contained carangids and scombrids up to 400 mm FL; one individual over 10 kg contained a 700+ mm FL belonid. Mahimahi from 4 to 17 kg contained flying fishes up to or exceeding 300 mm FL. In contrast, only a small portion of the diets of similarly-sized tuna consisted of exocoetids (all under 150 mm FL), carangids or scombrids, and those that were consumed tended to be smaller. The bulk of the diets of tuna consisted of smaller or more elongate fishes, and relatively small ommastrephid squids and crustaceans.

Seasonal trends in prey consumption were often difficult to ascertain due to widely varying monthly sample sizes, and in the case of yellowfin tuna, its tendency to feed mesopelagically as well as epipelagically. Among epipelagic prey species, the only apparent seasonal trend was a direct relationship between the occurrence of flying fish in the diet of mahimahi and the relative abundance of mahimahi. When flying fishes are scarce, the mahimahi replace them with other prey, primarily the epipelagic young of demersal species. Interestingly enough, this appears to occur precisely at the time of year when these epipelagic young are most abundant. However, the small contribution of many demersal families to the diets of pelagic predators made it difficult to ascertain seasonal trends with precision. This was impossible for blue marlin which were not sampled throughout much of the year, and difficult for yellowfin tuna which often fed mesopelagically.

For wahoo, skipjack tuna, and mahimahi, certain seasonal trends in the abundance of the young of demersal species in their diets were apparent (Figure 3). Collectively, there seems to be an increase in the occurrence of the young of demersal species in the spring and early summer (April-July), and to a lesser degree in November-December. Much of this was due to the contribution of acanthurids, particularly Naso unicornis, and to a lesser extent, of balistids. The relative abundance of holocentrids varied widely and differed between species.

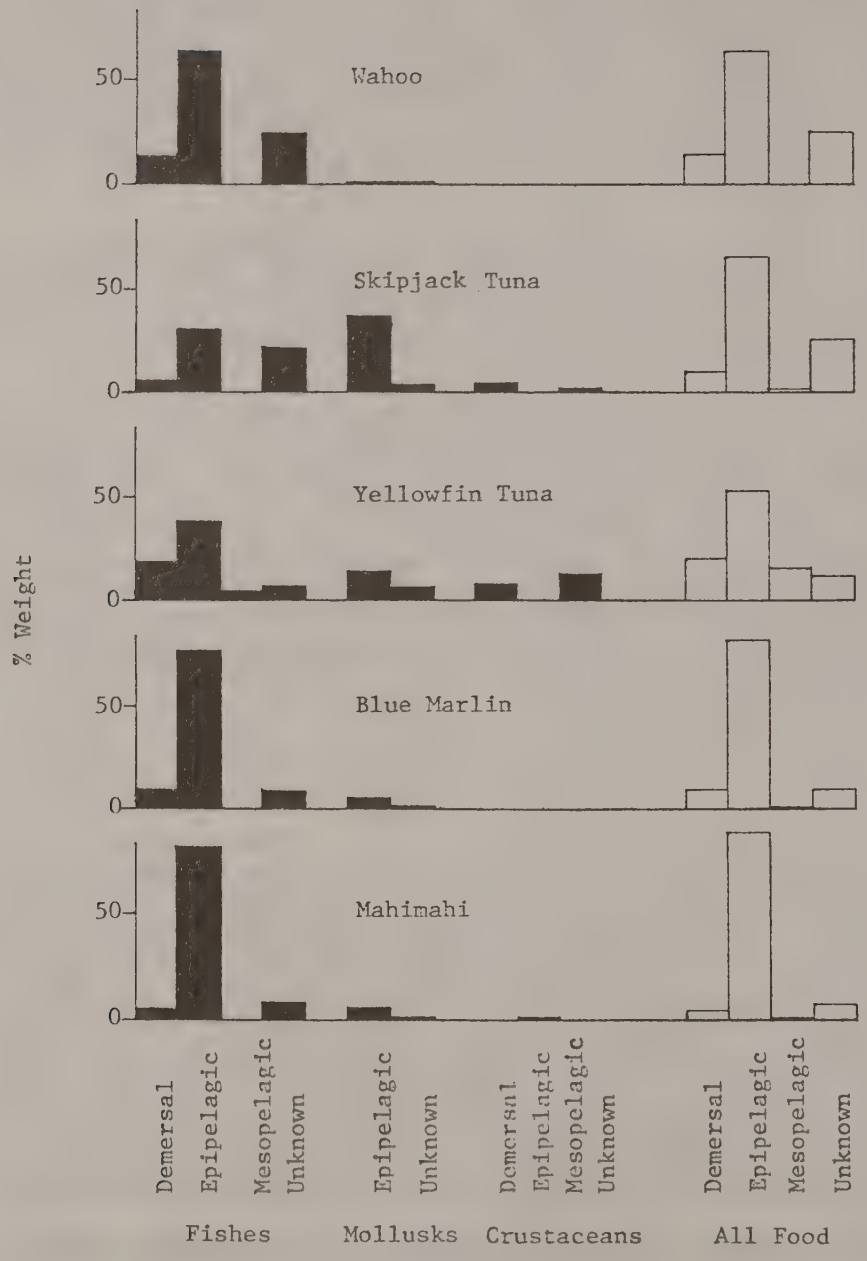


Figure 2. Proportional representation of ecological functional groups in the diets of five pelagic gamefishes in the vicinity of Guam.

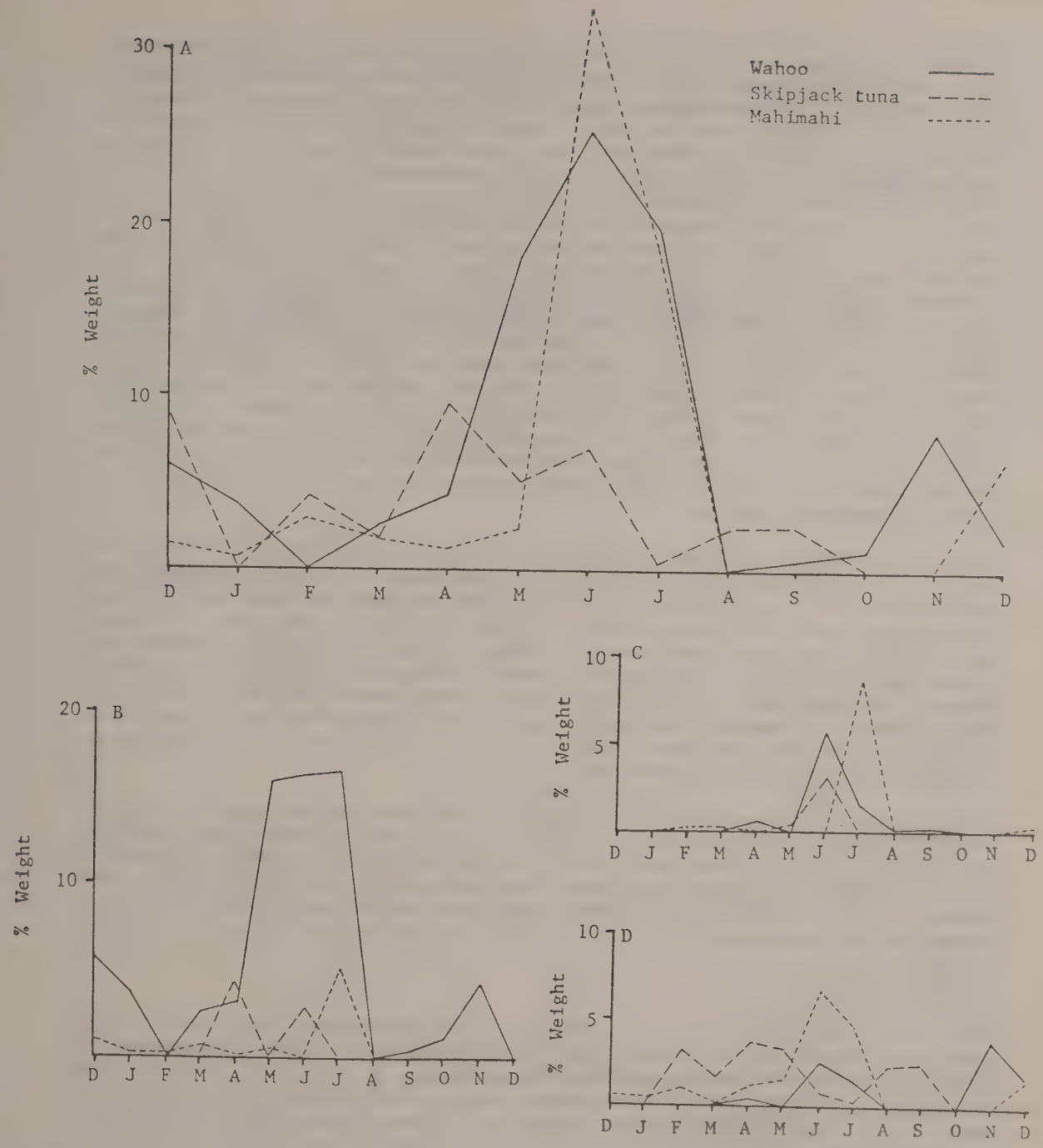


Figure 3. Seasonality of pelagic young of demersal fishes in the diets of five principle species of gamefishes from the vicinity of Guam from December 1981 to December 1982. A. Families Holocentridae, Mullidae, Chaetodontidae, Acanthuridae, Siganidae, Balistidae and Monacanthidae combined. B. Acanthuridae C. Balistidae D. Holocentridae

It was not possible to compare the diets of fishes obtained from different areas (including those obtained near FADs with those obtained elsewhere). This was due to several factors beyond the control of this study, including small monthly sample sizes for many species, and the inability to associate individual fish within a catch with particular areas of capture, or even of segregating catches by boat for a given day's catch.

Although it was not possible to assess the effects of FADs directly, numerous prey items have been observed in the vicinity of FADs. These include the carangids Decapterus macrosoma, Elagatis bipinnulatus, and juvenile Caranx sexfasciatus; the nomeid Psenes cyanophrys; juvenile Thunnus albacares and Coryphaena hippurus, juveniles of the balistid Canthidermis maculatus, and the monacanthid Pervager melanocephalus. Many of these fishes were significant prey of wahoo, a species which Guam's FADs have been particularly effective in attracting. They were not particularly important prey of mahimahi, another species effectively attracted to FADs, but were fairly important in the diets of blue marlin and yellowfin tuna. The FADs may be more effective in holding mahimahi during their "off" season when they appear to feed more often on the young of demersal species.

Clearly, epipelagic organisms, primarily fishes, are the most important prey of the five principle species of pelagic gamefishes of Guam. Although diet composition may vary considerably between regions or seasons, fishes, cephalopods, and crustaceans are the major dietary component of these gamefishes throughout the world. Pelagic young of demersal fishes and crustaceans comprise a significant portion of the diets of these predators, forming an important link between coastal and oceanic habitats. At least one of the five species, yellowfin tuna, feeds extensively on mesopelagic organisms, linking the lower regions of the mixed layer with the upper regions of cooler aphotic subsurface regions.

The results of this and other studies of the feeding behavior of pelagic fishes suggest an intimate relationship between coastal and pelagic ecosystems. Major alterations in the stocks of important pelagic predators may ultimately affect the recruitment and subsequent composition of inshore demersal resources and conversely, changes in the condition of inshore resources may ultimately affect offshore pelagic resources.

RECOMMENDATIONS

With the completion of this report it is recommended that this job be terminated, and that the results herein be considered in the management of both the inshore and offshore fisheries of Guam. It is further recommended that incidental life history data taken during this study be analyzed and used in conjunction with future studies of Guam's recreationally-important offshore fishes.

LITERATURE CITED

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Pinkas, L., M.S. Oliphant, and I.L.K. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Dept. of Fish and Game Fish Bull. 152, 105 pp.

Report prepared by: Robert F. Myers

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 1

JOB TITLE: Limnological Survey of the Major Streams and Rivers

PERIOD COVERED: October 1, 1983 to September 30, 1984

BACKGROUND

An ecological survey of the Agfayan River mouth was conducted by Aquatic & Wildlife Resources (DAWR) from July 1, 1968 to June 30, 1972. Salinity, pH and temperature data, as well as lists of organisms collected or observed in the river mouth were included in the Annual DAWR Progress Reports. This study dealt primarily with the estuarine system.

In a preliminary study to rehabilitate the Masso River Reservoir into a public fishing and recreation area (July 1, 1971 to June 30, 1972), small gobies, eels and shrimp are mentioned as the principal inhabitants of the reservoir and feeder streams.

A limnological survey of the major streams and rivers of Guam was initiated during the period of June 30, 1974 to July 1, 1975. The Geus River, located in the southern tip of the island, and the Lonfit River in the central highlands, were investigated. Six species of fish, three species of shrimp and an aquatic gastropod were observed or collected from the Geus River. Five of the six species of fish, and two of the three species of shrimp present in the Geus River were also collected or observed from the Lonfit River. Two species of aquatic gastropods were taken in the Lonfit River.

The Geus River was found to be unsuitable for stocking gamefish or development as a fishing area. The Lonfit River was judged suitable for a stocking and development program, however, this was deferred because of limited access to the river. The University of Guam Marine Laboratory Technical Report No. 16 (1974) discusses the physical, limnological and biological components of the Geus River drainage basin. Organisms were collected and catalogued from established stations on the Ylig, Geus and Umatac Rivers during FY 77. Preliminary stomach content analyses of three fish species, Microsicydium elegans, Eleotris fusca and Chonophorus guamensis were performed during the report period. The collection of air and water temperatures and flow readings was initiated during this period. Breeding and reproduction observations were made of one species of fish.

Water temperatures, flow rates and biological data were collected monthly from permanent monitoring stations on the Geus and Umatac Rivers during FY 1978. The Ylig River was monitored at 3 stations during November 1977 and March 1978.

Seven sampling stations were established on the Ugum and Bubulao River system. The names of the organisms present were listed in our Job Progress Report for FY 79. Observations on the spawning of Microsicydium elegans from the Geus River were included.

During FY 80, preliminary air and water temperature data and water samples were collected from two experimental watersheds in southern Guam. Floral and faunal collections were also made. Data from four vegetational transects were collected. Nitrate, nitrite, ortho and total phosphates, pH, conductivities, turbidity and hardness parameters were determined from water samples.

RESULTS

This job was inactive during the report period due to personnel limitations.

RECOMMENDATIONS

This job should be terminated until sufficient personnel are available to continue the investigations of Guam's limnological systems.

Report prepared by: Michael E. Molina

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: F
STUDY NO.: F-II
JOB NO.: 2

JOB TITLE: Masso River Watershed Studies

PERIOD COVERED: October 1, 1983 to September 30, 1984

BACKGROUND

During FY 79, the fauna of Masso Reservoir and its feeder streams was sampled. Aquatic organisms collected include two eels (Anquilla mormorta and A. bicolor), three gobies (Chonophorous guamensis, Microsicydium elegans, and Sicyopterus macrostetholepis) an eleotrid (Eleotris fusca), several shrimps (Atya sp., Caridina sp., and Macrobrachium lar), tadpoles of Bufo marinus, and a variety of insect larvae and small invertebrates.

RESULTS

This job was inactive during the report period.

RECOMMENDATION

This job should be continued at a relatively low level to allow occasional monitoring of the Masso watershed; especially since the Department of Parks and Recreation, Government of Guam, has recently expressd interest in further developing and maintaining the Masso Reservoir as a public park.

Report prepared by: Michael E. Molina

AQUACULTURE

Funding Source: National Marine Fisheries Service
(P.L. 88-309)
Government of Guam

PROJECT TITLE: Development of Tropical Polyculture Fish Farming

PERIOD COVERED: October 1, 1983 Through September 30, 1984

OVERVIEW

During FY 84, the Division of Aquatic and Wildlife Resources (DAWR) continued to work with the Guam catfish, Clarius macrocephalus, and the Thai catfish, Pangasius sutchi. Further testing was conducted with the Guam catfish in order to refine a practical technique to artificially induce spawning, achieve successful egg incubation and improve fry survival. Work conducted with the DAWR stock of Thai catfish primarily involved improving their diet and habitat as ways of promoting successful egg maturation for oogenesis. In addition to these projects, we continued to provide a limited amount of technical assistance to the aquaculture community and the general public of Guam (Table 1). However, the primary role of providing technical and field assistance to local aquaculture farmers has been assumed by the University of Guam Extension Service.

As part of this year's World Food Day celebration, the DAWR staff assisted in the planning and execution of a Governor's Symposium on Aquaculture that was held on October 14, 1983. During the meeting, the roles of the government and the private sector in developing aquaculture on Guam, including the marketing of aquaculture products, were discussed. Seventy-six people registered for the symposium and most felt that the topics discussed were very informative and worthwhile.

Other FY 84 activities included the showing of several short films and a slide/tape program on aquaculture to a number of people in the aquaculture community at a monthly meeting of the Guam Aquaculture Association. Also in July 1984, an agriculture fair was held near the Public Market in Agana, at which DAWR personnel assisted in the judging of aquaculture products which were submitted for display.

I. ARTIFICIAL REPRODUCTION OF THE GUAM CATFISH, CLARIUS MACROCEPHALUS

SUMMARY

A technique for successfully fertilizing and hatching eggs from Clarius macrocephalus has been refined for use by the fish farmers of Guam. Three artificial reproduction trials were held during the last half of FY 83. Immediately into FY 84, two more trials were run and both were successful in producing viable eggs that hatched normally. By blending the knowledge gained from all five trials, a practical technique for artificially spawning the Guam catfish has evolved. In all of the trials, adequate preparation, efficient execution and cleanliness were overriding factors influencing successful fertilization and hatching.

Table 1. People Given Technical Aquaculture Assistance From October 1, 1983 to September 30, 1984.*

NAME	LOCATION	AFFILIATION	INTEREST
John Simpson	Agana	Dept. of Education	Science Project
Austin Bowden-Kerby	Mangilao	University of Guam	Algae & Tilapia
Manuel Guerrero	Maite	Dept. of Labor	Labor Statistics
Joan Perry	Mangilao	Soil Conservation Service	Pond Construction
Roger Pflum	Yap	Marine Resources	General Aquaculture
Richard Croft	Pohnpei	State Fisheries	General Aquaculture
Floramilo Ouano	Tamuning	Brodie Mem. School	Tilapia
Bill Zolan	Mangilao	Water & Energy Resources	Algae
Josephine Lizama	Mangilao	Head Start	Guppies
Vincent Golembeski	Alaska	Dept. of Fish & Game - FRED	General Aquaculture
Debbie Grosenbaugh	Agana	Tenorio & Associates	Aquaculture Plan
Craig Zoodsura	Michigan	Private	General Aquaculture
Dr. Rajendran	Mangilao	University of Guam	Catfish & Tilapia
Vernon Brown	Mangilao	University of Guam	General Aquaculture
Ben Castro	Mangilao	Dept. of Corrections	Tilapia
Student Tour	Windward Hills	Guam Adventist Academy	General Aquaculture

*In addition to those listed, numerous local aquaculturists contacted the DAWR during the fiscal year for technical assistance covering a wide range of topics.

OBJECTIVE

To develop a practical technique for the artificial reproduction of the Guam catfish, *Clarius macrocephalus*.

PROCEDURES

Selection of Broodstock

For each trial, eight male/female pairs of catfish were randomly selected from a holding tank. All of the catfish used in the trials appeared to be mature, judging from their pinkish papillae, reddish vents, or enlarged abdominal regions. However, the success of artificial egg fertilization may be enhanced by selecting individual brooders based on the presence of certain characteristics which may indicate stronger reproductive potential. For example, selected males should be large, strong and healthy in appearance, and have long white papillae that are slightly pinkish at the tips. Since it is not possible to squeeze milt from *C. macrocephalus* males, such external characteristics must be used in selecting strong male brooders. Female brooders should be selected not only for appearing strong and healthy, with enlarged abdomens and reddish-colored vents; but also for possessing eggs that are dark brown with a slight greenish tinge, and which may be extruded fairly easily by applying slight pressure to the abdominal region of the fish or by suction through a thin plastic tube.

Preinjection Handling

Each selected catfish was quickly, yet very carefully measured, weighed, and isolated in a ten-liter plastic pail containing three liters of water. Care was taken to minimize stress whenever the fish were handled. A clear plastic tube etched with centimeter markings was used to measure total lengths; and a triple beam balance was used to determine weights. Two pails, one containing a male and the other a female, were placed into individual 189-liter holding troughs each containing about 72 liters of water (30 cm in depth). Each pail and holding trough was covered with plastic mesh to prevent the fish from escaping during the night. Individual fish were kept isolated until after the hormone injections on the following day. It was hoped that by suddenly joining together individuals of the opposite sex, which were also under the influence of reproductive hormone, ovulation might be further promoted or intensified.

Injection Handling

A handling routine was developed for injecting the fish with Human Chorionic Gonadotropin (HCG) hormone. On the day after isolation, the fish were injected according to the schedules outlined in Tables 2 and 3. Control fish were injected with a 0.9% saline solution at a rate representating the average amount of HCG given to the other fish. Disposal one cc tuberculin syringes were used for the injections and the needles were

sterilized with rubbing alcohol. Each fish received two injections six hours apart, comprising one third and two-thirds of the total dose, respectively. The injections were made into the dorsal intermuscular tissue above the lateral line. After the injections were administered, the fish were gently returned to their holding troughs, where each pair was allowed to swim freely together. The troughs were covered with a plastic mesh and the catfish were left until the next day.

Artificial Fertilization

Artificial fertilization of the catfish was performed on the morning following the day of the injections. The technique for egg fertilization remained basically the same in all five C. macrocephalus trials. In each case, the male testes were extracted, washed in a 0.9% saline solution and cut into a fertilization solution being held within a watch glass dish. The testes in this species appears as a paired, cream-colored organ within the abdomenal cavity that terminates near the anal opening of the fish. The testes were macerated in a saline (0.4%) and urea (0.3%) solution to help keep the sperm cells motile for a longer period of time. While the sperm solution was being prepared, the eggs were being gently stripped from the female into a clean glass dish. There was no need to strip every last egg from each female; only those eggs which flowed freely from applying gentle pressure to the abdomen with thumb and forefingers were obtained. The sperm solution was then carefully poured over the eggs and gently mixed. The cutting of the testes, stripping of the eggs and fertilization of the eggs were all done within sixty seconds. The sperm and eggs were allowed to sit for about three minutes. The fertilized eggs were then placed into prefabricated egg baskets after being washed several times with saline solution. All dead eggs were removed from the egg baskets with a clean eye dropper.

Egg Incubation

The fertilized eggs were incubated in compartmentalized baskets made from a fine-meshed nylon cloth that were suspended in glass aquaria inside the laboratory so that more uniform water temperatures could be maintained. In all five trials, the fertilized eggs were suspended in one to two centimeters of water. In the aquaria, water was circulated and aerated by a standard corner filter with an attached electric air pump.

Fry Growout

The fry were removed from the egg basket after one day and introduced into an aquarium where water depth was about 16 cm to completely cover a standard corner filter. The fry were fed brine shrimp (Artemia sp.) naupii three times a day. After 27 days in the aquarium, these fry were transferred to an outdoor fiberglass trough (2.8m x 0.3m x 0.2m) with a water depth of eight centimeters,

and monitored for growth. After the first six months the remaining fish were moved to a 757-liter, round fiberglass tank which contained flowing water also at a depth of eight centimeters. Small pieces of PVC pipe were placed in the trough and round tank to provide shelter for the fingerlings. The trough and round tank were cleared periodically in order to maintain good water quality and a clean environment for the fish. Fish food with a protein content of 27% was fed once a day to the fingerlings, at a rate of approximately six percent of their total body weight. For the first month, their diet was supplemented with a daily feeding of brine shrimp, Artemia sp. Total length (cm) and weight (gm) measurements were made periodically in order to monitor growth. Water temperatures were monitored throughout the project.

RESULTS

The male catfish that had been injected with hormones were found to have developed noticeably enlarged testes which were highly vascularized, and which generally appeared to contain more milt than the control-group males. The treated females were found to possess eggs that were darker in color, and which seemed to flow from the vent easier than those of the control-group females. The HCG hormone doses of 6 and 8 IU/gram of fish body weight, administered in two injections with six-hour intervals, produced the most sac fry.

During the fourth trial (the first conducted in FY 84) sac fry were noted on the 26th hour. However, a power outage that had occurred before the 26th hour had caused water circulation inside the aquaria to cease. Because of this, and concern for water quality in the aquaria, approximately 50 sac fry from Tank 2 and 30 sac fry from Tank 4 were pooled into the egg basket in Tank 3 which held approximately 225 sac fry. The egg basket with the pooled sac fry was then transferred to an aquarium containing freshly added water and a standard corner filter to facilitate circulation. Although power was restored later in the afternoon, approximately 80 percent of the fry had died after one day. Nearly one month later, the remaining fry were transferred to an outdoor holding trough; and by the 245th day, all of the catfish fingerlings had died. During that period, however, the fingerlings had grown an average of 3.9 cm in length and had gained an average of 4.4 gm in weight.

In the fifth trial, the same techniques were used for handling the fish and eggs. After 26 hours of egg incubation, Tanks 2 and 3 each produced approximately 175 catfish sac fry. Only a few sac fry hatched in Tank 4 and they died within a few hours. By the end of the next day, all sac fry had died. Poor water quality in the aquaria probably caused the mortalities. In all trials, the C. macrocephalus eggs in the control tanks rapidly turned white and died.

DISCUSSION

The results of the five trials have shown that it is possible to achieve egg maturation, ovulation, and successful artificial fertilization of C. macrocephalus eggs under hatchery conditions. Even though the fish responded positively to the HCG injections, it became quite apparent that adequate preparation, efficient execution and cleanliness were overriding factors influencing successful fertilization and hatching. The first three trials were executed with slight differences in order to develop a basic culture technique which not only had a good chance of success, but which could be implemented relatively easily by local fish farmers with a minimum of equipment and training. The basic step-by-step culture technique that evolved was used in the fourth and fifth trials. The sex ratios, hormone doses, and number of injections remained constant in both of these latter trials.

The major differences among the first three trials were discussed in DAWR's FY 83 annual report. In those trials, the HCG injection doses ranged from three to six IU/gram of fish body weight. In the last two trials, the HCG injection doses ranged from six to ten IU/gram. The only eggs that successfully hatched in the first three trials were from fish that had been injected with five IU/gram. In the last two trials, eggs hatched from fish injected at each dosage; but more sac fry hatched from fish injected at six to eight IU/gram than at ten IU/gram. The relatively greater success obtained in the latter two trials may also, in part, be attributed to the improvement of our overall culture technique, including the handling of both brooders and eggs.

The maintenance of high water quality and optimal water temperature are also very important factors in creating the proper environment for the incubation of fertilized catfish eggs. If the eggs are to be kept in an aquarium or other type of closed system, a sufficient volume of water should be provided for at least a twenty-four hour period. Otherwise, providing a continuous flow of clean, fresh water over the eggs will ensure that the maintenance of good water quality. Currently, there are a number of jar or tray incubators (available commercially) which provide continuous water flow conditions for hatching fish eggs. Regardless of the type of system that is used, however, it would be wise to only use water that either comes from a natural source or has been freed of all chlorine and other toxic substances before it circulates around the eggs by an in-line carbon filter.

RECOMMENDATIONS

As outlined in the technique presented for culturing the Guam catfish, C. macrocephalus, the catfish should be injected with HCG hormone to insure that proper egg maturation and ovulation occur. Based on the five trials conducted at the DAWR, the recommended hormone dose for this species is between five and eight IU/gram of catfish body weight. To achieve further success, the selection of male and female brooders should be based on characteristics expected to improve the success rate for artificial fertilization. While incubating the eggs, water

Table 2. Human chorionic gonadatropin (HCG) injection schedule administered to *Clarius macrocephalus* on October 27, 1983. Injection 1 was given at 1000 hrs. and Injection 2 was given at 1600 hrs. Tank 1 = control.

						Injection 1		Injection 2	
Tank	Sex	Total Length (cm)	Weight (gm)	Injection Rate (IU/gm)	Total Injection (IU)	0.9% Saline Solution (IU)	HCG (IU)	0.9% Saline Solution (IU)	HCG (IU)
	Male	21.5	72.7		736.5	245.5		491.0	
1	Female	23.5	97.4		736.5	245.5		491.0	
	Male	22.5	68.9		736.5	245.5		491.0	
	Female	22.0	75.2		736.5	245.5		491.0	
	Male	23.0	82		492		164.0		328.0
2	Female	21.5	82.8	6	496.8		165.5		331.2
	Male	22.5	75.0		450.0		150.0		300.0
	Female	22.5	79.2		475.2		158.4		316.8
	Male	22.5	77.5		620.0		206.6		413.4
3	Female	26.0	127.0	8	1016.0		338.6		677.4
	Male	20.0	63.6		508.8		169.6		339.2
	Female	25.0	105.7		845.6		281.9		563.7
	Male	24.0	92.9		929.0		309.7		619.3
4	Female	27.0	153.7	10	1537.0		512.3		1024.6
	Male	21.0	67.6		676.0		225.3		450.6
	Female	22.0	79.2		792.0		264.0		528

Table 3. Human chorionic gonadatropin (HCG) injection schedule administered to Clarius macrocephalus on November 3, 1983. Injection 1 was given at 1000 hrs. and Injection 2 was given at 1600 hrs. Tank 1 = control.

						Injection 1		Injection 2	
Tank	Sex	Total Length (cm)	Weight (gm)	Injection Rate (IU/gm)	Total Injection (IU)	0.9% Saline Solution (IU)	HCG (IU)	0.9% Saline Solution (IU)	HCG (IU)
	Male	20.5	58.9		552.0	184.0		368.0	
1	Female	21.0	74.7		552.0	184.0		368.0	
	Male	20.5	74.7		552.0	184.0		368.0	
	Female	21.0	65.8		552.0	184.0		368.0	
	Male	21.5	66.6		339.6		132.2		264.4
2	Female	21.5	76.8	6	460.8		153.6		307.2
	Male	20.0	63.7		382.2		127.4		254.8
	Female	19.5	59.7		358.2		119.4		238.8
	Male	21.5	67.3		538.4		179.5		358.9
3	Female	20.0	67.0	8	536.0		178.6		357.4
	Male	20.0	54.8		438.4		146.1		292.3
	Female	21.5	82.5		660.0		220.0		440.0
	Male	21.0	72.3		723.0		241.0		482.0
4	Female	21.0	64.0	10	640.0		213.3		426.7
	Male	21.5	70.9		709.0		236.3		472.7
	Female	21.0	78.3		783.0		261.0		522.0

quality and water temperature should be carefully controlled in order to increase hatching success. Future work at the DAWR should involve testing the culture technique used for the Guam catfish on other species of catfish, such as Clarius batrachus and Pangasius sutchi, which currently posses greater commercial potential.

II. ARTIFICIAL REPRODUCTION OF THE THAI CATFISH, PANGASIUS SUTCHI

SUMMARY

No artificial reproduction trials were conducted with the Thai catfish, Pangasius sutchi, since their eggs did not properly maturate during the 1984 breeding season. At different times during the year, portions of the Thai catfish broodstock was moved from the fish rearing facility at the Department of Agriculture to a pond at Inarajan in order to check their response to the pond environment, and to insure their survival because of high chlorine levels in the water supply at the facility. The major thrust of this year's work was to improve the quality of environmental and dietary factors that may help promote the maturation of Thai catfish eggs under natural conditions. An apparent positive response was noted in the fish after pond introduction; and it is recommended that the broodstock continue to be kept in the pond environment during all future culture attempts.

OBJECTIVES

1. To achieve oogenesis and egg release in the Thai catfish, Pangasius sutchi at Guam.

2. To develop a viable methodology for artificially reproducing P. sutchi, and for rearing its hatchlings to the fingerling stage at Guam.

PROCEDURES

Specific procedures related to artificially reproducing Pangasius sutchi were developed, but were only partially implemented during FY 84 due to the untimely death of most of our experimental fish. Therefore, these methods will be implemented and reported with their results at a later date.

In preparation for the artificial reproduction trials, a special diet was formulated and fed to the brooders. The diet consisted of the following ingredients: tangan-tangan leaves (Leucaena sp.), yeast powder, dried kelp, vitamin E, and high-protein/low-fat powdered feed. Individually, tangantangan leaves and yeast powder each comprised 1% of the daily allotment. Kelp tablets, each containing 225 mg of iodine, were pulverized and added to the daily feed mixture at a rate of just under ½ a tablet per fish. Natural vitamin E was added to the feed mixture after the mixture had been moistened to a paste consistency with water. The vitamin E was added at an average daily rate of approximately 35 IU per fish.

The high-protein/low-fat powdered feed (manufactured in Taiwan) represented the major portion of the feed mixture. The fish were fed a daily amount of food approximately equal to 2% of their total, combined body weight. After all of the ingredients were mixed together, the paste was formed into small balls which were randomly broadcast to the catfish in each tank of water. The Thai catfish utilized in this project were held in one 11.9 m x 1.5 m x .9 m cement raceway, and three 3974 l fiberglass tanks.

Early in the season, ten females were introduced into a 0.4 hectare pond in Inarajan to see if the pond environment might help stimulate egg maturation. These fish were fed a 27%-protein, pelleted feed from an automatic electric feeder. Their diet was supplemented with ground tuna. The pond was visited weekly, during which observations on weather conditions, pond water color, fish activity, air and water temperatures, and other characteristics were recorded. Beginning in June 1984 the Thai catfish in this pond, as well as those in the cement raceway and fiberglass tanks, were checked monthly for the presence of ripe eggs.

RESULTS

The overall mean weight of our P. sutchi brooders in April 1984 was approximately 2.0 kg. The mean weights for males and females were 1.8 kg and 2.1 kg, respectively. Between April and June most of the female catfish in the raceway exhibited a gradual enlargement of their ventral regions. During the same period, none of the females held in the round fiberglass tanks showed any similar changes in external appearance, and were noted as being easily excited and not as anxious to feed as the raceway catfish. An examination of two raceway catfish at the end of June revealed the cause of the observed ventral enlargement to be the development of an abundance of white, immature eggs.

On Sunday, July 29, 1984 all of the catfish appeared to be stressed. Worse yet, eleven dead catfish were found in two of the tanks. One fish was observed having muscle spasms as it frequently turned over while floating near the surface of the water. It died shortly thereafter. A field necropsy performed on all of the dead fish showed no abnormalities. As a result, high chlorine levels in the water were suspected, and this was checked with the free and total chlorine test kit (Model CN-70) made by the Hach Company. Total chlorine levels in the tank water were found to range from 0.1 to 0.6 mg/l. The inflowing water contained chlorine levels up to 1.5 mg/l. For the next few days, all of the catfish appeared as if they might be improving, although still under stress. On August 2, two of the females being held in the round fiberglass tanks died. By August 3, all of the remaining catfish were moved to the freshwater pond at Inarajan to ensure their survival. At that time, further plans to artificially reproduce these fish were postponed until FY 85.

During the weekly visits to the pond the sky was usually partly cloudy and the mean air temperature was 29.3°C. The mean surface water temperature in the pond was 29.4°C. The pond color usually varied

between milky green to brown green. On most visits, the pond surface was smooth with some ripples on the windward side. The water level remained constant in the pond. The catfish could usually be seen surfacing in the pond for air or food. Frequently, the electronic feeder was on and shooting pellets into the pond. Also, tilapia (Oreochromis sp.), freshwater prawns (Macrobrachium sp.), and Asian catfish (Clarius sp.) were stocked with the Thai catfish.

The monthly examinations for the presence of ripe eggs revealed that many of the females had developed an enlarged ventral region with a red puffed up vent. No viable eggs were observed in the fish during the four examinations. The males were all found to be in excellent condition and many had red vents. Particles from the feed and plant materials from within the pond were observed in their feces. All fish always appeared healthy and in prime condition. On September 21, 1984, an attempt was made to sex and weigh some of the catfish in the pond. Of the nine fish sampled, five males and four females had mean weights of 2.4 kg and 2.8 kg, respectively. These data indicate that the Thai catfish experienced a desirable weight gain after being stocked into the pond.

DISCUSSION

In attempting to artificially reproduce P. sutchi we have been particularly concerned with the final stages of gamete maturation within females. For the last several years our attempts to induce ovulation among mature females, during their reported breeding seasons, have been unsuccessful. In contrast, there has never been a problem in obtaining viable milt from males. Since it is known that the development and maturation of viable eggs within the reproductive tract of female fish can be strongly influenced by environmental factors (Harvey and Hoar 1979), we attempted in FY 84 to improve the condition of our broodstock by raising the quality of their diet, and by transferring them to a more natural pond environment, before attempting to artificially reproduce them again.

Prior to FY 84, all of the induced breeding work conducted on P. sutchi by DAWR staff was done with fish that had been kept (out of necessity) under relatively crowded conditions in a 16 m^3 cement raceway. Furthermore, since the fish were first stocked in the raceway they have been fed an unsupplemented diet of either artificial feed or ground tuna; and have been intermittantly subjected to unannounced, short-term introductions of chlorine into their water supply by local public health and public utilities agencies. It is conceivable that these factors may have placed a long-term stress on the fish, which has resulted in their continued failure to produce mature eggs.

Lagler, Bardach and Miller (1962) have also indicated that the food consumed by fish over a period of time may affect the development of mature eggs. In their natural environment, fish can usually feed on a variety of items that contain all of the vitamins and minerals required for successful reproduction and other biological process. In aquaculture, fish diets are often supplemented with artificial feeds which provide a balanced diet containing the basic nutrients required for maintenance

and growth. Often, however, the vitamins contained in artificial feeds experience a rapid deterioration which ultimately reduces the nutritional value that is made available to the fish. Most fish that are reared in raceways and tanks feed almost entirely on artificial feeds, and do not have the opportunity to select additional food items which might be available in a pond or other type of natural environment. These considerations are important for fish reared in aquaculture systems because the type of food provided for them can directly influence the development, growth, and maturation that takes place within their reproductive systems.

The catfish stocked in the pond during this report period appeared to respond positively to their new environment even though mature eggs were not obtained. Because of this apparent positive response, exhibited as a spurt in growth, it may be prudent to maintain the broodstock under pond conditions for at least a year. Hopefully, the effects of more natural environmental conditions will result in the production of viable, mature eggs during the 1985 breeding season.

RECOMMENDATIONS

1. Because of the apparent positive response to the pond environment, the Thai catfish should be left in the pond and observed periodically for viable eggs.

2. Carbon filters should be installed at the DAWR fish rearing facility to prevent fish kills due to excessive chlorine levels in the public water supply.

REFERENCES CITED

Harvey, B.J. and W.S. Hoar. 1979. Theory and practice of induced breeding in fish. International Development Research Centre, Ottawa, Ontario. 48 pp.

Langler, K.F., J.E. Bardach, and R.R. Miller. 1962. Ichthyology. John Wiley & Sons, Inc., New York. 545 pp.

Report prepared by: Wayne Kruckenberg

GUAM WILDLIFE INVESTIGATIONS
PROJECT FW-2R-21
Federal Aid in Wildlife Restoration Act

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer.

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Hunting license sales increased dramatically over the past five years (1980-84) up 48%, as did the number of legal deer hunters and hunter effort, up 76% and 108% respectively. Hunter success and the estimated legal harvest rose consistently during the early 1980's, peaking in 1983 and declining in 1984. Hunter effort in 1984 surpassed 4,200 days afield (2421 8-Hour days) with an estimated 348 deer hunters harvesting 46 deer. The most popular deer hunting areas remained Northwest Field (NWF), Naval Communications Area Master Station (NAVCAMS), Dandan, and the Tarzan Falls (Cotal), Anao, and Bolanos Conservation Reserves. Spotlight count data over the past five years indicated an increase in the deer population at Pati Point, Andersen Air Force Base (AAFB) and a gradual decrease in deer numbers at the Naval Magazine (NAVMAG).

BACKGROUND

The Guam Deer has been under investigation by the Division of Aquatic and Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures.

OBJECTIVES

To determine the current size and distribution of the population of deer on Guam and to monitor population trends.

PROCEDURES

1. Increase the number of spotlight counts on AAFB to 30 per year, 4 per month in May - July and twice in other months.

    a. Record number, age, sex and group composition.

    b. Statistically analyze count data and compare with past data to discern population trends.

2. Continue monthly spotlight counts on Naval Magazine with periodic spotlight counts in other areas.

3. Collect hunting statistics via a hunter questionnaire mailed in January. Analyze hunting statistics for changes in hunter kill, effort, and hunting location.

4. Collect biological data from carcasses killed during regular season or from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

Hunting license sales increased for the fourth year in a row in FY 1984 to 506 licenses sold, up 8.4% over FY 1983 and 48.4% over FY 1980. The regular deer season ran from October 1, 1983 to December 31, 1983 with a season bag limit of one antlered deer.

Regulations were adopted during FY 1984 to allow "either-sex" hunting of deer in selected areas of AAFB when deemed necessary by the Director of Agriculture. The newly adopted regulations will make it easier and faster for the Division to schedule a "special hunt" when the situation warrants. The General Hunting Regulations were also changed to allow hunting of deer with handguns of .357 magnum, .41 magnum and .44 magnum calibers in FY 85. A regulation also adopted to take effect in FY 85 stipulates that all hunters and carriers must wear hunter orange while pursuing game.

Following the October-December deer season, a hunter questionnaire was mailed to license holders. One hundred forty-four license holders (28.5%) responded to the questionnaire (Table 1). Of the 144 respondents, 113 (78.5%) reported that they had hunted game. Based on that proportion, an estimated 397 persons hunted game during FY 1984, a 9.7% increase in legal hunters from the 362 reported for FY 1983.

Ninety-nine of the 113 responding hunters (87.6%) reported that they had hunted deer during the past season. Thirteen deer were reported taken yielding a success rate of 13.1%. The reported kill was distributed in the following areas; NWF-7, NCS-2, Tarzan Falls-1, and private lands-3.

Hunters were also asked to provide information on animals wounded and not found, weapons used, and hunting effort. Five hunters (5.1% of deer hunters) reported they had wounded and not found a deer, yielding a hunter loss estimate of 38.5% of the harvest. Three were lost by shotgun hunters and two by rifle hunters. The shotgun was the weapon of choice for deer hunting being used by 78% of the reporting deer hunters for 86% of the hunting effort. Rifles were used by 14% of the deer hunters for 6% of the hunting effort and bows were used by 11% of the deer hunters for 8% of the hunting effort. The 99 deer hunters reported they went deer hunting 1197 days, an average of 12.1 days per hunter, and spent an average of 4.6 hours per day hunting, yielding an average of 7.0 8-hour days hunting per person, an increase of 2.0 days over FY 1983 levels.

Table 1. Island-wide deer hunting statistics for FY 1984.

a.	Total license sales for all game species	506
b.	Number of hunter questionnaires returned	144
c.	Percent of license buyers reporting	28.5%
d.	Number of reporting license buyers (144) that hunted any species	113
e.	Percent of license buyers that hunted any species	78.5%
f.	Estimated total number of legal hunters	397
g.	Number of reporting hunters (113) that hunted deer	99
h.	Percent of reporting hunters that hunted deer	87.6%
i.	Number of deer taken by 99 deer hunters	13
j.	Hunter success (i ÷ g x 100)	13.17%
k.	Estimated total number of legal deer hunters (fxh)	348
l.	Estimated total legal deer take (jxk)	46
m.	Number of hunter days expended by 99 reporting deer hunters	1197
n.	Average number of days spent per reporting deer hunter (m÷ g)	12.1
o.	Estimated total number of days spent hunting deer (kxn)	4211
p.	Number of days spent hunting per deer taken (o÷ 1)	91.5
q.	Average number of hours spent hunting per day afield	4.6
r.	Estimated total number of 8-hour days spent hunting deer (oxq ÷ 8)	2421
s.	Average number of 8-hour days spent hunting (r÷ k)	7.0
t.	Number of 8-hour days spent hunting per deer taken (r ÷ 1)	52.6

Northwest Field (NWF) and NAVCAMS remained the more popular and heavily hunted areas on the island with 53.5% and 31.3% of the responding hunters reporting they hunted there (Table 2). NWF received the heaviest hunting pressure with an estimated 1,646 hunter days (946 8-hour days) expended there and followed closely by NAVCAMS at 1368 hunter days (787 8-hour days). Territorial conservation reserves received an increase in hunting pressure this year with Tarzan Falls hunted 281 days (162 8-hour days) by 10.1% of reporting hunters, Bolanos hunted 99 days (57 8-hour days) by 8.1% of the hunters, and Anao hunted 179 days (103 8-hour days) by 6.1% of the hunters. The three conservation reserves received 322 8-hour days of hunting pressure, an increase of 104% over the 158 8-hour days reported in FY 1983. Private lands were also popular for hunting with the Dandan area hunted by 7.1% of reporting hunters a total of 193 days (111 8-hour days) and other private lands hunted 239 days (137 8-hour days) by 9.1% of deer hunters.

Estimates of total hunter participation, kill, and effort for the season were derived from information on the hunter questionnaire. Based on questionnaire data an estimated 348 hunters hunted deer and harvested 46 deer from the following areas; NWF-25, NAVCAMS-7, Tarzan Falls-4, and private lands - 10, a sharp decrease from the estimated harvest of 119 deer for FY 83. The dramatic drop in harvest can be attributed to the absence of an AAFB "special hunt" this past year which usually accounts for as large a harvest as all other areas combined. Even though hunter kill decreased considerably in FY 84, total hunter effort increased 60% over FY 83 levels to 2421 8-hour days. Consequently with the increase in effort and decrease kill, hunter effort per deer taken increased over 3 fold from 12.7 8-hour days per deer in FY 83 to 52.6 8-hour days per deer in FY 84.

An accurate record of hunter effort and take kept in official logs at NWF and NAVCAMS military installations compares fairly closely with the estimated values of hunter effort and take derived from the hunter questionnaire (Table 3). The reported take of 7 deer over 901.5 8-hour days at NAVCAMS compares closely to the estimated 787 8-hour day effort and 7 deer harvest derived from the questionnaire (Table 2). At NWF, the official log recorded a 14 deer harvest for 966 8-hour days effort versus the estimated 946 8-hour days effort and 25 deer harvest. The discrepancy in kill data for NWF can be attributed to the fact that successful hunters are more likely to respond to a questionnaire than unsuccessful hunters.

Over the past 5 years, FY 80-84, interest, participation and effort expended in deer hunting have increased dramatically (Table 4). Total license sale rose 48%, the estimated number of deer hunters rose 76% to 348 hunters, and the effort expended (days spent hunting deer) increased 108% to 2421 8-hour days (4211 hunter days where a hunter day is any part of a day spent hunting). Legal harvest and hunter success rose during the early 80's and peaked in FY 83 at 119 deer harvested and 39.4% hunter success. The peak in success and harvest in FY 83 can be attributed to the large harvest of "special hunt" deer in FY 83. No "special hunt" was held in FY 84 and subsequently the harvest and hunter success dropped sharply to below FY 80 levels, and effort per take more than doubled any of the earlier years. The sharp decline in hunter success and increase in effort per take in FY 84 occurred even though the harvest on NWF and NAVCAMS (the most popular and heavily hunted areas) increased to the

Table 2. Deer hunting statistics broken down by popular hunting areas based upon hunter questionnaires returned by 99 deer hunters for FY 1984.

A[1] Hunting locations	B[1] No. of hunters	C[2] % Deer hunters	D[1] No. days hunting	E[1] No. deer taken	F[3] % Hunter success	G[4] Effort per deer taken (days/deer)	H[5] Estimated total days hunting	I[6] Estimated 8-hour days hunting	J[7] Estimated kill	K[8] Estimated Effort/deer taken (8-hr. days/deer)
NWF	53	53.5	468	7	13.2	67	1646	946	25	38
NAVCAMS	31	31.3	389	2	6.5	195	1368	787	7	112
Tarzan	10	10.1	80	1	10.0	80	281	162	4	41
Bolanos	8	8.1	28	0	0	-	99	57	0	-
Dandan	7	7.1	55	0	0	-	193	111	0	-
Anao	6	6.1	51	0	0	-	179	103	0	-
NAVFAC	2	2.0	35	0	0	-	123	71	0	-
AAFB	2	2.0	23	0	0	-	81	47	0	-
Private	9	9.1	68	3	33.3	23	239	137	10	14

[1]Information in columns A,B,D,E - compiled from hunter questionnaires.

[2]%deer hunters - derived from column B ÷ 99x100; where 99 deer hunters responded to the questionnaire.

[3]%hunter success - derived from E ÷ Bx100.

[4]Effort per deer taken - derived from D ÷ E.

[5]Estimated total days hunting - derived from (D ÷ ΣDx4211; where 4211 is the estimated total number of days spent hunting deer (Table 1).

[6]Estimated 8-hour days hunting - derived from (Hx4.6) : 8; where 4.6 is the average number of hours spent hunting deer per day afield with Hx4.6 equal to total hours spent hunting.

[7]Estimated kill - derived from (Cx348)xF; where 348 is the total number of legal deer hunters (Table 1) and (Cx348) is estimated legal deer hunters per specific area.

[8]Estimated effort/deer taken (8-hour day/deer) - derived from (I ÷ J).

Table 3. Hunter effort and deer take based on official hunter logs from NAVCAMS and NWF, FY 1984.

	NAVCAMS			NWF			
	No. hunter sorties	No. hunter 8-hour days	Deer Taken	No. hunter days	No. hunter sorties	No. hunter 8-hour days	Deer taken
October	657	361	3	646	869	448.5	7
November	548	292.5	1	439	587	301.5	1
December	472	248	3	322	420	216	6
Total	1677	901.5	7	1407	1876	966	14
Hunter effort per deer taken	239.6	128.8	-	100.5	134.0	69.0	-

Table 4. Trend in hunter participation, effort, and harvest from FY 1980 - FY 1984.

	1980	1981	1982	1983	1984
Total license sales	341	333	358	467	506
Estimated no. legal deer hunters	198	200	217	302	348
Estimated legal harvest	50	57	67	119	46
Hunter success	25.0%	28.6%	30.8%	39.4%	13.1%
Estimated hunter effort (8-hour days)	1164	1240	1628	1510	2421
Hunter effort/deer taken (8-hour days/deer)	23.5	21.7	24.3	12.7	52.6
Average days hunting	5.9	6.2	7.5	5.0	7.0
Official harvest NAVCAMS	10	2	2	2	7
Official harvest NWF	4	6	5	15	14

highest level in 5 years. The trend is clear that the deer population and harvest in NWF and NAVCAMS cannot keep pace with the large increase in interest and participation in deer hunting. Under such conditions hunter success will remain low and effort required to bag a deer high.

Spotlight Count Trends

Spotlight counts on AAFB were increased from 12 to 30 during FY 84, 4 per month during the dry season in May-July and twice in other months (Table 5). The average number of deer seen per count increased from 68.3 in FY 83 to 79.9 in FY 84, a non-significant increase (Mann-Whitney U-Test, U=233 P=0.14; Sokal and Rohlf 1981). The largest number of deer seen on any monthly count increased from 100 in FY 83 to 118 in FY 84. The continued increase in deer numbers at AAFB appears to be a continuation of the general increasing trend observed over the past 5 years (Table 7).

The number of deer seen during month counts varied considerably over the year from 33 in November to 118 in July. Visibility and deer numbers can be low during the rainy season when the grass is high and deer are easily concealed from view. Consequently, visibility is best and deer numbers counted high during the dry season. In a test of this relationship, the number of deer seen per count during the dry season, May-July, was significantly higher than the number of deer seen per count in other months. (Average May-July = 89.3, other months 73.7; Mann-Whitney U-Test, U=151.5, $P < 0.05$, one tailed test).

Deer on the runways became a problem at AAFB with the collision of a deer and a C-130 Cargo Plane in the middle of the North Runway on 17 Jan 84. GAWR recommended that a sport hunt be scheduled to thin the herd, harvest problems animals, and instill "fear of man" in the deer. To resolve the problem the Air Force chose to conduct an unauthorized control program from May through August, Twenty-seven deer were shot and turned over to GAWR for processing and donation to charitable agencies. One deer, a fawn, was captured alive and released elsewhere on the island. A legitimate special hunt was scheduled for December, FY 85 to further reduce the herd.

The average number of deer seen per count at NAVMAG decreased again for the 3rd year in a row from 16.9 in FY 83 to 9.3 in FY 84, a significant decrease (Mann-Whitney U-Test, U=105, $P < 0.10$). The largest number of deer seen on any count also decrease from 36 in FY 83 to 22 in FY 84 (Table 6). These data indicate that the NAVMAG herd is continuing the gradual decline which started in the early 70's (Table 7; Wheeler, 1979).

Feral Asiatic Water Buffalo

Sightings of water buffalo (Carabao) were included during the spotlight counts at NAVMAG. The average number of water buffalo seen per count decreased from 43.7 in FY 83 to 34.0 in FY 84 (Table 6 and 7), a non-significant decrease (Mann-Whitney U-Test, U=95.5, $P > 0.10$). The maximum count also showed a large decrease over the past year, down 37.3%. The decline in water buffalo over the past 2 years comes after a peak in number seen in 1982 and appears to coincide with the deer decline.

Table 5. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, FY 1984.

		1983			1984										AVE. NO. COUNT	STD. DEVIATION	COEF. VAR
	Count	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	TOTAL			
Unclassed Buck	1	6	6	6	2	0	1	0	8	7	3	3	3	105	3.5 n=30	2.57	73%
	2	5	2	8	0	1	2	6	8	4	3	3	3				
	3								2	2	4						
	4								1	7	1	2	2				
	$\bar{x}$	5.5	4.0	7.0	1.0	0.5	1.5	3.0	4.7	5.0	2.7	2.5	2.5				
Spike	1	3	1	1	2	4	1	9	0	2	5	1	1	54	1.8 n=30	1.94	108%
	2	2	0	2	1	1	3	0	1	1	5	1	3				
	3								1	0	2						
	4								0	1	0						
	$\bar{x}$	2.5	0.5	1.5	1.5	2.5	2.0	4.5	0.5	1.0	3.0	1.0	2.0				
2 PT	1	1	2	3	1	0	0	2	2	3	1	0	1	60	2.0 n=30	1.72	86%
	2	3	0	5	6	3	1	2	5	4	4	2	3				
	3								1	0	4						
	4								0	1	0						
	$\bar{x}$	2.0	1.0	4.0	3.5	1.5	0.5	2.0	2.0	2.0	2.3	1.0	2.0				
3 PT	1	4	4	4	4	1	7	6	3	3	2	4	9	117	3.9 n=30	2.14	55%
	2	4	1	5	8	3	2	5	5	2	5	2	7				
	3								5	1	5						
	4								1	4	1						
	$\bar{x}$	4.0	2.5	4.5	6.0	2.0	4.5	5.5	3.5	2.5	3.3	3.0	8.0				
4 PT	1	0	0	1	1	1	0	0	0	0	1	1	0	12	0.4 n=30	0.81	202%
	2	0	0	1	4	0	1	0	0	0	0	1	0				
	3								0	0	0						
	4								0	0	0						
	$\bar{x}$	0.0	0.0	1.0	2.5	0.5	0.5	0.0	0.0	0.0	0.3	1.0	0.0				
DOE	1	40	30	28	26	29	24	57	42	40	43	52	49	1130	37.7 n=30	11.59	31%
	2	33	18	42	26	30	34	35	63	49	61	33	48				
	3								33	25	40						
	4								29	46	25						
	$\bar{x}$	36.5	24.0	35.0	26.0	29.5	29.0	46.0	41.7	40.0	42.3	42.5	48.5				
Yearling	1	2	4	5	2	2	0	3	0	0	6	8	4	129	4.3 n=30	3.01	70%
	2	1	2	9	3	4	2	2	7	3	6	10	8				
	3								9	2	4						
	4								4	8	9						
	$\bar{x}$	1.5	3.0	7.0	2.5	3.0	1.0	2.5	5.0	3.3	6.3	9.0	6.0				
Fawn	1	1	1	4	3	0	3	3	5	7	11	7	4	123	4.1 n=30	2.92	71%
	2	4	1	2	0	1	3	2	1	5	5	9	9				
	3								6	6	9						
	4								4	5	2						
	$\bar{x}$	2.5	1.0	3.0	1.5	0.5	3.0	2.5	4.0	5.7	6.7	8.0	6.5				

Table 5. Continued.

		1983			1984									TOTAL	AVE. NO. COUNT	STD. DEVIATION	COEF. VAR
	Count	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT				
Unclassed Deer	1	22	19	19	8	27	22	26	22	33	46	24	23	667	22.2 n=30	9.76	44%
	2	10	9	11	11	12	15	27	15	15	22	45	17				
	3								28	22	29						
	4								22	40	26						
	$\bar{x}$	16.0	14.0	15.0	9.5	19.5	18.5	26.5	21.7	27.5	30.7	34.5	20.0				
Total	1	79	67	71	49	64	58	106	82	95	118	100	94	2397	79.9 n=30	21.78	27%
	2	62	33	85	59	55	63	79	105	83	111	105	97				
	3								85	58	97						
	4								61	112	64						
	$\bar{x}$	70.5	50.0	78.0	54.0	59.5	60.5	92.5	83.3	87.0	97.5	102.5	95.5				
Km Traveled $\bar{x}$		10.1	10.1	9.9	16.5	7.2	7.4	7.7	7.8	7.9	8.2	8.2	8.5		9.2 n=12		
Deer / 10 Km $\bar{x}$		69.8	49.5	78.8	32.7	82.6	81.8	120.1	106.8	110.1	118.9	125.0	112.4		90.7 n=12	29.74	33%
Deer / 10 Miles $\bar{x}$		111.7	79.2	126.1	52.3	132.2	130.9	192.2	170.9	176.2	190.2	200.0	179.8		145.1 n=12	47.58	33%
Bucks in Velvet	1	3	4	6	3	0	0	9	7	5	0	1	2	92	3.2 n=29	3.02	94%
	2	7	1	9	4	1	2	6	10	1	2	0	1				
	3								2	0	2						
	4								ND	4	0						
	$\bar{x}$	5.0	2.5	7.5	3.5	0.5	1.0	7.5	6.3	2.5	1.0	0.5	1.5				

Table 6. Composition of deer herd and number of water buffalo seen during spotlight counts at Naval Magazine, FY 1984.

	1981			1982										AVE. NO. COUNT	ST. DEVIATION	C.V.
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL			
Unclassed Buck	1		1	2									4			
Spike						1							1			
2 PT													0	0.83	1.27	153%
3 PT	1		1	2	1								5			
4 PT													0			
Doe	8	1	5	7	4	5	5	3	4			2	44	3.7	2.57	69%
Yearling	1					1		1	1				4	0.3	0.49	163%
Fawn	1					1	2						4	0.3	0.65	217%
Unclassed Deer	3		4	11	9		4	3	10	3	2		49	4.1	3.87	94%
TOTAL	15	1	11	22	14	8	11	7	15	3	2	2	111	9.3	6.58	71%
Km Traveled	22.2	21.1	21.6	21.9	22.1	23.8	23.4	23.2	23.2	23.0	22.4	23.4	271	22.6		
Deer / 10 Km	6.8	0.5	5.1	10.0	6.3	3.4	4.7	3.0	6.5	1.3	0.9	0.9	49.4	4.1	2.97	72%
Deer / 10 Miles	10.8	0.8	8.1	16.1	10.1	5.4	7.5	4.8	10.3	2.1	1.4	1.4	78.8	6.6	4.76	72%
Water Buffalo	41	36	52	44	22	33	11	42	43	45	27	12	408	34	13.3	39%

Table 7. Trend in deer and water buffalo spotlight counts FY 1980 - FY 1984.

	1980	1981	1982	1983	1984
Deer-AAFB					
Average count	55.1	47.5	66.4	68.3	79.9
Maximum count	80	66	90	100	118
Deer-NAVMAG					
Average count	16.0	25.1	19.4	16.9	9.3
Maximum count	32	41	31	36	22
Water Buffalo-NAVMAG					
Average count	33.1	36.9	58.2	43.7	34.0
Maximum count	69	91	76	83	52

RECOMMENDATIONS

Continue the increased number of spotlight counts on AAFB during the dry season. Collect biological data from carcasses killed during the AAFB special hunts.

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Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUBPROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Determination of Diet Quality of Guam Deer

PERIOD COVERED: October 1, 1983 to September 30, 1984

OBJECTIVES:

1. To investigate differences in diet nutritional quality between the AAFB and NAVMAG deer herds and between the water buffalo and deer populations on NAVMAG and to establish baseline DAPA index values for both herds seasonally and between years.

2. To investigate seasonal variation in the nutrient quality of key deer forage plants.

3. To investigate variation in the nutrient quality of individual deer diets.

RESULTS

This job was initiated during this segment and field work undertaken from March through September. Deer pellets and Pennisetum polystachyon grass samples were collected on a monthly basis from Andersen Air Force Base (AAFB; deer pellets and grass samples only) and Naval Magazine (NAVMAG), areas supporting the two major deer herds on the island. In addition, water buffalo (carabao) scats were collected from NAVMAG. Composite samples of deer pellets and water buffalo scats (NAVMAG only) were collected from each area once a month with the deer composite sample composed of 3 pellets from 15 different fresh groups and the water buffalo sample composed of about 10 ml of feces from 15 different fresh droppings. Approximately 100 gms of fresh grass was collected for the composite grass sample from each area.

Fecal and rumen samples were also collected from deer carcasses confiscated from poachers, road kills and deer shot on the runway areas of AAFB. Body measurements were taken and a kidney fat and marrow fat content indices of body condition calculated for each carcass, when possible. All fecal, rumen, and grass samples were oven-dried at 40oC for 24-48 hours.

The Wildlife Habitat Management Services, Department of Forestry and Range Management, Washington State University, was contracted to perform

DAPA (diaminopimelic acid) content analysis on the fecal samples and nutrient analysis for crude protein, grass energy, and Calcium/Phosphorous content on the grass and rumen samples. During segment 21, 91 samples - seven monthly grass, deer, and water buffalo samples from AAFB and NAVMAG and 28 individual deer fecal and rumen samples, were collected for analysis. One batch was shipped for analysis in August and a second batch shipped in November 1984. Further analysis of the results awaits receipt of laboratory analysis.

Thirty-two deer were examined and or processed for biological data during segment 21; 3 fawns were examined alive, measured and released or turned over to the zoo; 7 deer were road kills or confiscated from poachers; and 22 deer were shot on the runway areas by the Air Force and turned over to GAWR for examination and donation to needy agencies. Body measurements and biological data from these animals is compiled in Table 1 for males and Table 2 for female deer. The relationship between body size, condition, and diet nutrient quality will be further analyzed pending receipt of laboratory results.

Report prepared by: Paul J. Conry

Table 1. Measurements of Male Guam Deer examined during FY 1984.

Specimen No.	Area	Date[1]	Age	Wt	KFI[2]	% FCM[3]	Body Measurements (cm) TL[4]	Tail	HF[5]	Hoof	SH[6]	Girth[7] (Shld)	Neck[8] (Shld)	Neck[9] (Jaw)	Head	Ear
832	Yigo	16-1-84	3mo	2.7	10	ND	63	6.1	19.5	3.1	36	30	13	ND	ND	6.2
8411	AAFB	20-7-84	3mo	5.5	ND	ND	71	6.4	22.5	2.7	43	40	19	17	18	7.4
8412	NWF	25-7-84	2-3mo	5.8	17.9	33.3	70	6.6	21.8	3.2	44	48	22	18	17	7.1
8417	AAFB	20-6-84	1yr	26.0	26.7	39.6	114	12.3	32.8	4.2	68	67	34	27	25	9.8
843	Yigo	2-3-84	adult	76.4	93.1	92.2	143	11.1	33.9	4.3	87	104	63	47	ND	10.9
8410	AAFB	22-7-84	adult	62.3	14.8	8.1	142	10.3	34.1	5.2	80	91	63	45	33	10.4
8416	AAFB	4-8-84	adult	41.0	32.0	60.9	129	10.1	34.1	4.4	73	76	42	34	29	10.1
8418	AAFB	17-6-84	adult	42.8	67.8	87.2	132	11.6	34.7	4.6	79	80	40	33	31	10.9
8420	AAFB	7-2-84	adult	63.6	66.4	86.1	146	7.6	35.2	4.7	83	97	61	49	33	10.4
8421	AAFB	16-8-84	adult	61.4	47.1	ND	152	9.8	38.2	5.0	95	91	57	43	35	10.1
8422	AAFB	14-6-84	adult	84.1	27.3	63.3	171	12.9	37.2	5.7	92	98	64	49	38	11.6
8423	AAFB	12-5-84	adult	77.3	59.7	ND	154	10.8	37.8	6.0	85	102	68	57	32	11.5
8425	AAFB	27-5-84	adult	45.5	19.5	70.1	135	12.0	34.7	5.2	76	83	43	37	28	10.9
8427	AAFB	12-5-84	adult	38.6	37.1	44.2	129	11.0	34.0	4.7	71	80	41	31	29	10.6
8431	AAFB	23-5-84	adult	50.0	18.9	45.6	143	12.0	36.0	4.4	80	87	50	36	31	11.1
8432	AAFB	28-5-84	adult	44.1	44.1	92.7	134	11.8	33.3	4.9	78	88	44	34	28	10.4
8433	AAFB	21-5-84	adult	70.5	15.2	54.5	156	12.2	34.8	5.9	82	97	59	46	35	11.0

1 Date specimen collected
2 KFI Average kidney fat index for both kidneys. KFI = wt fat. wt kidney x 100.
3 % FCM Percentage fat content of bone marrow (usually the femur).
4 TL Total length in cm.
5 HF Hindfoot length in cm.
6 SH Height at shoulder in cm.
7 Girth Circumference of chest at shoulder.
8 Neck (Shld) - Circumference of neck at shoulder.
9 Neck (Jaw) - Circumference of neck at jaw.
10 ND No data collected.

Table 1. Measurements of Male Guam Deer examined during FY 1984 (Con't).

Specimen No.	# Points LxR	Antler Measurements (cm) Greatest Length L	Greatest Length R	Basal Cir. L	Basal Cir. R	Greatest Spread	Tip to Tip	Notes
84-2	0							
84-11	0							
84-12	0							
84-17	1x1						-	buttons
84-3	4x3	33.5	33.4	19.2	19.0	34.5	?	in velvet
84-10	3x3	32.2	26.7	15.0	15.5	25.6	24.1	
84-16	9x7	16.9	8.8	12.9	13.4	20	20.5	irregular
84-18		antlers recently dropped						in velvet
84-20	3x3	32.4	31.5	13.4	13.3	30.7	30.0	in velvet
84-21		antlers broken off						in velvet
84-22	?x3	broken	39.4	-	20.4	-	-	
84-23	4x4	33.0	33.5	18.0	17.5	35.5	30.5	
84-25	3x?	23.0	broken	15.3	-	-	-	
84-27	1x1	3.3	3.4	7.5	7.9	11.5	10.5	
84-31	2x2	21.6	24.1	13.5	12.8	19.4	16.5	
84-32	2x2	27.0	26.6	14.0	13.5	19.5	10.5	in velvet
84-33	3x3	37.6	35.4	17.6	17.7	29.3	26.5	in velvet

Table 2. Measurements of Female Guam Deer examined during FY 1984.

Specimen No.	Area	Date[1]	Age	Wt (kg)	KFI[2]	% FCM[3]	Body Measurements (cm) TL[4]	Tail	HF[5]	Hoof	SH[6]	Girth[7] (Shld)	Neck[8] (Shld)	Neck[9] (Jaw)	Head	Ear	Notes
83-1	Yigo	11-4-84	fawn	2.5	ND[10]	ND	61	5.4	18.7	2.6	35	32	ND	15	ND	6.1	live-immature
84-28	AAFB	12-5-84	fawn	11.4	14.0	43.5	83	7.0	25.5	3.4	51	43	22	20	20	7.0	immature
84-29	AAFB	12-6-84	fawn	5.5	102.5	83.3	71	6.7	21.7	3.0	42	35	18	16	17	6.5	immature
84-30	AAFB	25-9-84	1 yr	25.0	174.0	74.5	103	7.9	31.6	4.0	74	73	23	25	24	8.0	immature
84-2	ZOO	7-1-84	4 yrs	27.6	19.2	34.0	121	10.2	28.2	4.9	69	70	30	26	ND	10.0	nongravid
84-1	NCS	2-12-83	adult	56.8	244.0	92.4	ND	ND	24.0	5.4	71	86	43	ND	ND	ND	nongravid
84-7	NCS	26-5-84	adult	36.0	67.1	88.9	131	9.3	30.3	4.7	65	76	35	29	25	10.2	gravid & lactating
84-8	NCS	13-1-83	adult	32.0	110.3	89.4	129	9.2	31.0	3.6	65	84	31	27	25	9.8	lactating
84-9	NWF	18-6-84	adult	52.3	242.6	95.0	135	10.1	30.2	4.4	79	88	43	32	29	9.5	gravid & lactating
84-13	AAFB	27-7-84	adult	35.0	17.4	34.8	117	9.6	33.8	4.7	73	74	35	32	27	10.4	lactating
84-14	AAFB	8-8-84	adult	31.2	53.9	57.5	114	10.0	31.9	4.2	66	77	33	31	10	10.2	gravid
84-15	AAFB	8-8-84	adult	38.8	43.7	49.7	123	10.4	33.4	4.2	75	81	39	32	26	10.2	gravid
84-19	AAFB	7-6-84	adult	43.2	23.0	92.4	132	10.4	32.6	4.7	74	78	34	29	31	10.1	lactating
84-24	AAFB	17-9-84	adult	31.8	43.5	ND	118	9.8	29.5	4.4	70	76	40	32	25	9.9	gravid & lactating
84-26	AAFB	19-3-84	adult	17.3	60.8	74.7	96	7.0	28.1	3.8	65	59	23	29	22	8.2	nongravid

[1] Date specimen collected
[2] KFI Average kidney fat index for both kidneys. KFI = wt kidney fat/wt kidney x 100.
[3] % FCM Percentage fat content of bone marrow (usually the femur bone).
[4] TL Total length in cm.
[5] HF Hindfoot length in cm.
[6] SH Height at shoulder in cm.
[7] Girth Circumference of chest at shoulder in cm.
[8] Neck (Shld) Circumference of neck at shoulder in cm.
[9] Neck (Jaw) - Circumference of neck at jaw in cm.
[10] ND - No data collected.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Wild Pigs.

PERIOD COVERED: October 1, 1983 to September 30, 1984

OBJECTIVES

To prepare a status report on wild pigs to be used in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job will be implemented and completed in Segment 22 provided adequate manpower is made available. Additional data collected during Segments 20-22 will be included in the report.

Report prepared by: Paul J. Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT: W-1
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Hunter participation, effort and harvest increased dramatically in FY 1984. An estimated 339 hunters spent 8293 days (4872 8-hour days) and harvested an estimated 1085 pigs, an increase of 27% in hunter participation, 200% in hunter effort, and 140% in harvest over FY 83 levels. Hunter success remained the same as FY 83 but the average take increased 85% to 4.8 pigs per successful hunter and the effort expended for each pig harvested increased 25% to 7.6 days (4.5 8-hour days). A great deal of the increase in hunter effort and harvest can be attributed to the lengthened pig season. An estimated 230 hunters hunted 3013 days during January to March and harvested an estimated 483 pigs. As in the past, the military installations of Northwest Field (NWF) and Naval Communications Area Master Station (NAVCAMS) were the most popular hunting areas with Anao, Tarzan Falls, and Bolanos Conservation Reserves and Dandan and other private lands also listed as popular hunting areas.

BACKGROUND

The wild pig (Sus scrofa) is one of Guam's two game mammals. The wild pigs on Guam descend from stock introduced by the Spanish during their 300-year role on the island. Wild pigs are found island-wide, though appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam. Depredation on agricultural crops is often a problem, especially for farmers in southern Guam during the dry season. Fieldwork on pigs in the past has been concentrated on military lands. There is a need to assess pig populations in other areas of the island, particularly in the south, where pigs may be under-harvested and where crop damage by pigs is a common complaint.

OBJECTIVES

To determine current population size and distribution and to monitor trends.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.

2. Conduct surveys using sign counts, flushing counts, or other methods, to determine the relative abundance of pigs in the Bolanos Conservation Area.

3. Monitor the harvest of pigs during the legal hunting season.

RESULTS

PIG HUNTING STATISTICS

New regulations took effect during FY 83 that liberalized the pig season and take, lengthening the season 3 additional months to October 1 through March 31, island wide, and increasing the season limit from 10 to 20 pigs and the daily limit from 1 to 2 pigs. After the close of the FY 84 season in March 84, additional regulations were promulgated that further liberalized the season and limit to year round pig hunting in southern Guam and an increase in the season limit to 30 pigs.

Two questionnaires were mailed to license holders; the first mailed in February covered the period October through December coincident with the deer season, and the second questionnaire, mailed in October, covered the extended season from January through March. License sales increased 8.7% to 506 licenses sold during FY 1984. Of these, 144 license buyers (28.4%) responded to the first questionnaire and 88 license buyers (17.4%) responded to the second questionnaire. Covering the first 3 months of hunting 113 (78.5%) of the 144 respondents to the first questionnaire reported they actively hunted, yielding an estimate of 397 legal hunters (Table 1) during the season. Of the 88 license holders responding to the second questionnaire, 72 (81.8%) reported they had hunted during the season yielding a second estimate of 414 legal hunters during the season, 4.3% greater than the estimated derived on the first questionnaire.

Based on questionnaire responses (Table 1), 81.9% of reporting hunters hunted pigs this past season an increase from 73.4% reported in FY 83. Sixty-six percent of the reporting hunters successfully took pigs during the season killing an average of 4.8 pigs per successful hunter. Hunter success remained the same as last year but the average kill per successful hunter increased 85%, a major portion of which is attributable to the extended season. Pig hunters expended an average of 24.5 days hunting during season (14.4 8-hour days) an increase of 136% over FY 83. Over the entire season, 7.6 days (4.5 8-hour days) of hunting effort were expended for each pig taken, an increase of 25% over FY 83.

Estimates of total harvest and hunter effort were derived from hunter questionnaires. For the 6 month season, an estimated 339 pig hunters spent 8293 days (4872 8-hour days) hunting pigs and harvested 1085 pigs. This is an increase from 266 hunters hunting 1623 8-hour days and harvesting 452 pigs in FY 83, and represents a dramatic increase in hunter participation (27%) hunter effort (200%), and hunter harvest (140%).

Table 1. Island-wide Pig Hunting Statistics for FY 1984

		Questionnaire 1[1]	Questionnaire 2[2]	All Season[3]
a.	Total license sales for year	-	-	506
b.	Number of hunter questionnaires returned	144	88	-
c.	Percent of license buyers reporting	28.4%	17.4%	-
d.	Number of reporting license buyers that hunted any species	113	72	-
e.	Percent of license buyers that hunted any species	78.5%	81.8%	-
f.	Estimated total number of legal hunters (axe)	397	414	414
g.	Number of reporting hunters that hunted pigs	94	59	-
h.	Percent of reporting hunters that hunted pigs	83.2%	81.9%	89.9%
i.	Number of successful pig hunters	47	39	-
j.	Hunter success	50%	66.1%	66.1%
k.	Number of pigs taken by reporting pig hunters	177	187	-
l.	Average number of pigs taken per hunter	1.9	3.2	3.2
m.	Average number of pigs taken per successful hunter	3.8	4.8	4.8
n.	Estimated total number of legal pig hunters	330	339	339
o.	Estimated total legal pig take	627	1085	1085
p.	Number of reporting pig hunters that hunted the extended season (Jan-March)	-	40	-
q.	Percent of pig hunters that hunted the extended season	-	67.8%	-
r.	Estimated number of hunters hunting extended season	-	230	-
s.	Number of successful hunters during extended season	-	230	-
t.	Hunter success during extended season	-	57.5%	-
u.	Reported number of pigs taken during extended season	-	83	-
v.	Average number of pigs taken per hunter	-	2.1	-
w.	Average number of pigs taken per successful hunter	-	3.6	-
x.	Estimated take during extended season	-	483	-
y.	Reported number of days spent hunting during early and extended season	1507	523	-
z.	Average number of days spent hunting per hunter during early, extended, and all season	16.0	13.1	24.5
AA.	Number of days spent hunting per pig taken during early, extended, and all season	8.4	6.2	7.6
BB.	Average number of hours spent hunting per day afield	4.7	-	4.7
CC.	Estimated total number of 8-hour days spent hunting during early, extended, and all season	3102	1770	4872
DD.	Average number of 8-hour days spent hunting	9.4	7.7	14.4
EE.	Number of 8-hour days hunting per pig taken	4.9	3.7	4.5

[1]Questionnaire 1 - reports on hunting activity from Oct. 1 - Dec. 31, 1983. Estimated derived from questionnaire 1 pertain to the early season only.

[2]Questionnaire 2 - mailed in Oct. 1984 and had questions pertaining to season long hunting activity (responses A-O and 2-EE) and to the extended season only responses P-EE).

[3]All Season - responses derived from questionnaire 2 or a combination of questionnaires 1 and 2.

A great deal of the increase in hunter effort and harvest can be attributed to the added hunting opportunities provided by the 3 month extension of the pig season through March in FY 84. An estimated 230 hunters participated during the extended season (67.8% of all pig hunters), hunted an estimated 3013 days (1770 8-hour days) and harvested an estimated 483 pigs (table 1).

Hunter success increased slightly from 50% to 57.5% during the extended season but average take per successful hunter declined slightly from 3.8 to 3.6 pigs. Overall the extended season provided a significant increase in hunter participation and harvest.

The most popular areas to hunt pigs remained the military bases on the northern half of the island. Northwest field (NWF) was hunted by 51% of reporting hunters, NCS by 43% and Naval Facility by 3%. Anao, Tarzan Falls, and Bolanos Conservation Reserves were also popular hunting spots as were Dandan and other private lands.

A record of hunting activity and harvest was kept in official hunter logs at NAVCAMS and NWF military installations (Table 2). Both areas received a dramatic increase in hunting activity and harvest over FY 83 levels. Hunter sorties increased 111% on NAVCAMS and 183% on NWF. Hunter effort reach 1238 8-hour days at NAVCAMS and 1206.5 8-hour days (1735 hunter days) at NWF. Hunter harvest also increased dramatically from 20 to 148 pigs on NAVCAMS and from 57 to 181 pigs on NWF. The effort expended per pig harvested decreased at NAVCAMS and increased at NWF compared to FY 83 levels.

A further analysis of long term population trend and hunting statistics will be presented in a technical report to be completed in FY 85.

RECOMMENDATIONS

Continue to monitor the annual pig harvest. Devise a hunter questionnaire strategy that will better sample pig hunter participation, effort, and harvest over the year long season for FY 85. Collect biological information and samples from animals at hunter check stations.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1983. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.

Report prepared by Paul Conry

Table 2. Hunter effort and pig take based on official hunter logs from NAVCAMS and NWF during FY 1984

	NAVCAMS			NWF			
	No. hunter sorties	No. hunter 8-hour days	Pig take	No. hunter days	No. hunter sorties	No. hunter 8-hour days	Pig take
October	657	361	55	646	869	448.5	61
November	548	292.5	37	439	587	301.5	42
December	472	248	24	322	420	216	18
January	266	133.5	11	96	121	69.5	12
February	149	76.5	10	60	94	47.5	15
March	236	126.5	11	172	245	123.5	33
Total	2328	1238	148	1735	2336	1206.5	181
Hunter effort per pig taken	15.7	8.4	-	9.6	12.9	6.7	-

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Philippine Turtle Doves.

PERIOD COVERED: October 1, 1983 to September 30, 1984

OBJECTIVES

To prepare a status report on Philippine Turtle Doves for use in planning future work.

RESULTS

This job was inactive during this segment due to the shortage of staff.

RECOMMENDATIONS

This job will be implemented and completed in Segment 22 provided adequate manpower is made available. Additional data collected during Segments 20-22 will be included in the report.

Report prepared by: Paul J. Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-R-21
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle Doves.

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Because of the closure of Northwest Field during the July bird season, very little Philippine Turtle Dove (PT Dove) hunting was done during FY 83. Based on hunter questionnaire, an estimated 29 dove hunters expended 197 hunter days (99 8-hour days) and harvested 122 doves, a drop in hunter participation, effort, and harvest from FY 83. Average take per hunter decreased from 7.4 birds in FY 83 to 4.2 birds in FY 84. The Naval Communications Area Master Station (NAVCAMS), Dandan, and Cross Island Road were the areas reported as hunted during the season. Philippine Turtle Doves numbers remained low over most the island with no significant difference between FY 83 and FY 84 stationary counts at NWF and roadside counts on Andersen Air Force Base. However, the numbers of Marianas Fruit Doves and White-throated Ground Doves observed during stationary counts on NWF declined significantly from FY 83 to FY 84.

BACKGROUND

Until recently, the Philippine Turtle Dove (Streptopelia bitorquata) was the only game bird on Guam. It was introduced by the Spanish about 1771 from the Philippines (Baker, 1951). The Philippine Turtle Dove has been a regulated game bird since the first hunting season was established in 1965. The FY 1982 hunting season was July 1 to July 31, with a daily limit of four birds and a season limit of twenty, whereas in FY 1983 the season length and season limit remained the same but the daily limit was increased to 5 birds. Although considerable work has been done in the past on nesting and movement of Philippine Turtles Doves (Drahos, 1977) current effort is restricted to population counts and monitoring of hunter harvest.

OBJECTIVE

To determine present population levels and distribution and monitor harvest and population trends.

PROCEDURES

Call count surveys and roadside counts were conducted at NWF and the Conventional Weapons Storage Area (CWA) on Andersen Air Force Base (AAFB). Both surveys were conducted in early morning. The call count survey consist of counting the number and species of doves seen or heard during a 5 minute period at 10 stations in NWF plus the number of doves seen enroute between stations. The roadside count at CWA involved counting the number of Philippine Turtle Doves seen while driving at 25 km per hour along an established 32 km route. The Philippine Turtle Dove is also censused in a bi-weekly roadside count survey conducted in 3 areas of northern Guam (Job W-1-3) and in an annual or monthly forest bird survey (Job W-4-1-3) conducted in 4 areas of northern Guam. The annual hunter harvest during the legal season was monitored at hunter checking stations and by a direct mail questionnaire distributed at the end of the hunting season. Information from the hunter questionnaires was used to estimate the number of Philippine Turtle Doves harvested during the season.

RESULTS

Dove Hunting Statistics

The legal dove season for FY 84 was July 1 to July 31 with a daily limit of 5 birds and a season limit of 20 birds. As NWF was not opened for hunting during the July bird season, very little hunting took place. Responses to a hunter questionnaire mailed to all license holders after the close of the hunting season indicated that only 5 of 72 hunters (6.9% replying to the questionnaire had hunted doves. The dove hunting statistics based on the hunter questionnaire are summarized in Table 1. Estimates of total hunter participation, effort, and harvest were derived from questionnaire data. Because of the low number of hunters responding, participation, effort, and harvest may be greatly over-estimated.

Based on the questionnaire, an estimated 29 hunters expended 197 hunter days (99 8-hour days) and harvested an estimated 122 doves over the season. The three areas reported as hunted were NAVCAMS, Cross Island Road and Dandan, the latter two simultaneously hunted for Black Francolin. Responding hunters reported hunting an average of 6.8 days (3.4 8-hour days) and harvested an average of 4.2 birds per hunter down from 7.4 birds in FY 83. The dove hunters reported hunting an average of 4.0 hours per day. The take per effort increased through from 1.17 birds per day in FY 83 to 1.23 birds per day in FY 84.

The official hunter log from NAVCAMS recorded less dove hunting than reported by hunters. The official log listed 3 hunter days with no harvest versus reports of a total of 22 hunter days expended and 18 bird harvested on NAVCAMS in the questionnaire, due evidently to some confusion and erroneous answers on the part of hunters responding to the questionnaire.

POPULATION SURVEYS

Call count surveys and roadside counts were continued in the NWF and the Conventional Weapons Storage Area on Andersen Air Force Base. The results of those surveys are presented in Table 2. The mean numbers of

Table 1. Island-wide Philippine Turtle Dove hunting statistics, FY 1984.

a.	License sales.	506
b.	Number of hunter reports/questionnaires returned.	88
c.	Percent of license buyers reporting.	17.4%
d.	Number of reporting license buyers that hunted any species.	72
e.	Percent license buyers that hunted.	81.8%
f.	Estimated total number of legal hunters.	414
g.	Number of reporting hunters (d) that hunted doves.	5
h.	Percent of reporting hunters that hunted doves (g ÷ d x 100).	6.9%
i.	Number of successful dove hunters.	5
j.	Percent of reporting dove hunters that took doves (i ÷ g x 100).	100%
k.	Number of doves taken by (g) dove hunters.	21
l.	Average number of doves taken per hunter (k ÷ g).	4.2
m.	Average number of doves taken per successful dove hunter (k ÷ i).	4.2
n.	Estimated total number of legal dove hunters (fxh).	29
o.	Estimated total legal dove take (mxl).	122
p.	Number of days expended by reporting dove hunter.	34
q.	Average number of days spent hunting per reporting dove hunter.	6.8
r.	Estimated total number of days spent hunting doves (mxq).	197
s.	Number of days spent hunting per dove taken (r ÷ o).	1.6
t.	Number of doves taken per day (o ÷ r).	0.62
u.	Average number of hours spent hunting per day.	4.0
v.	Estimated total number of 8-hour days spent hunting (rxu ÷ 8).	99
w.	Estimated number of 8-hour days spent hunting per bird taken (w ÷ o)	0.81
x.	Number of doves taken per 8-hour day (o ÷ w).	123

Table 2. Number of birds observed on Northwest Field call count surveys and Andersen Air Force Base roadside counts in FY 1984.

	Count No.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average Count	S.D.	C.V.
Northwest Field																
Philippine	1	61	46	44	41	58	39	74	61	46	59	88	61			
Turtle Dove	2	-	-	-	-	-	-	63	53	114	58	62	48			
	3	-	-	-	-	-	-	64	-	51	-	-	-	59.5	17.3	29%
	x	61.0	46.0	44.0	41.0	58.0	39.0	67.0	57.0	70.3	58.5	75.0	54.5	n=20		
White-throated	1	1	0	0	2	0	0	2	0	1	0	1	0			
Ground Dove	2	-	-	-	-	-	-	0	3	1	0	0	1	0.65	0.87	134%
	3	-	-	-	-	-	-	1	-	0	-	-	-	n=20		
	x	1.0	0.0	0.0	2.0	0.0	0.0	1.0	1.5	0.7	0.0	0.5	0.5			
Marianas Fruit	1	2	0	2	2	3	1	2	0	3	1	2	1			
Dove	2	-	-	-	-	-	-	1	0	0	2	1	1	1.65	1.4	85%
	3	-	-	-	-	-	-	6	0	3	-	-	-	n=20		
	x	2.0	0.0	2.0	2.0	3.0	1.0	3.0	0.0	2.0	1.5	1.5	1.0			
Andersen Air Force Base																
Philippine	1	21	20	40	47	55	61	111	60	70	61	47	81	57.3	24.1	42%
Turtle Dove	2	-	-	-	-	-	-	-	83	84	50	57	26	N=17		
	x	21.0	20.0	40.0	47.0	55.0	61.0	111.0	71.5	77.0	55.0	52.0	53.5			

PT Doves observed at NWF on call count surveys remained essentially the same as in FY 83, 59.5 in FY 84 versus 57.1 in FY 83 (AWRD 1983), no significant difference between years (Mann Whitney U-Test, U=122, $P > 0.20$; Sokal and Rohlf 1981). Likewise, there was no significant difference between numbers of PT Doves seen during roadside counts in the CWA on AAFB (Mann Whitney U-Test, U=27.5, $P > 0.20$), even though the mean number observed per count differed considerably, $\bar{x}$ in FY 83 = 106.6 versus $\bar{x}$ in FY 84 = 57.3. The small sample size in FY 83 and large variability between pre and post hunting season counts accounts for the apparent discrepancy.

Observations on the native White-throated Ground Dove and Marianas Fruit Dove were also collected on the NWF call count survey during FY 83 and FY 84. The numbers of White-throated Ground Doves observed per count decreased significantly from FY 83 to FY 84 (Mann Whitney U-Test, U=186, $P = 0.01$). The mean number of ground doves observed per count declined from 3.2 in FY 83 to 0.87 in FY 84, a 73% decrease.

Likewise, the numbers of Marianas Fruit Doves observed per count also decreased significantly from FY 83 to FY 84 (Mann Whitney U-Test, U=198.5, $P = 0.002$). The mean number of fruit doves observed per count declined from 5.0 in FY 83 to 1.65 in FY 84, a 67% decrease.

The declining trend in native dove populations as evident in the stationary call counts on NWF is additional evidence to further document the general decline of Guam birds. As for the Philippine Turtle Dove, its numbers are also declining (AWR 1983) with numbers apparently reduced in CWA and depressed but stable in NWF. PT dove numbers throughout the rest of the island remain low.

RECOMMENDATIONS

1. Continue call count and roadside count surveys in northern Guam to monitor distribution, relative abundance and population trends of Philippine Turtle Dove.

2. Continue to monitor hunter harvest and adjust hunting seasons and bag limits to provide for sustained yield management of dove populations.

3. Collect information on age and sex ratios, molt, and food habits from hunter harvested birds.

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Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Preparation of a Status Report on Black Francolin.

PERIOD COVERED: October 1, 1983 to September 30, 1984

OBJECTIVES

To prepare a status report on Black Francolin to be used in planning future work.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job will be implemented and completed in Segment 22 provided adequate manpower is made available. Additional data collected during Segments 20-22 will be included in the report.

Report prepared by: Paul J. Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 2

JOB TITLE: Population Size and Distribution of Black Francolin on Guam

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

A two month split season - January and July - was held for Black Francolin during FY 84. An estimated 121 hunters spent 619 days hunting Black Francolin and harvested an estimated 463 birds. The July season was the more popular of the two and it accounted for 436 days hunting and 351 birds. Dandan was the most popular area to hunt francolin on the island with the Tarzan Falls area also reported as hunted. Black Francolin numbers appear to have stopped increasing with no difference recorded in annual mean calling activity between FY 83 and FY 84 in Dandan and Pulantat but a significant decrease in calling activity was recorded in Talofofo.

BACKGROUND

In 1961, 171 Black Francolin (Francolinus francolinus) were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4 bird daily limit and a 20 bird season limit. Francolin populations continued to increase from 1980-1982 but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consistently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY 1983 to a 2 month-split season, 1 month in January and 1 month in July, with the bag limit increased to 5 bird per day, no season limit. The Division arranged a special hunt in the Dandan area in southern Guam during the last 2 weekends of July 1983 to obtain carcasses for disease sampling and biological data. A number of hunters participated and successfully harvested birds. No evidence of disease was found in the specimens examined to date.

OBJECTIVES

To determine current relative abundance and current distribution of Black Francolin on Guam and monitor populations trends and hunter harvest.

PROCEDURES

1. Conduct monthly call count surveys in areas of savannah habitat.
2. Conduct pre and post hunt call count surveys in the Dandan.
3. Monitor hunter harvest and collect data on harvested birds.
    a. Collect information on hunter effort and take at hunter check station.
    b. Collect data on age ratios, sex ratios, reproductive status, and food habits of harvested birds.
    c. Compile and analyze information on francolin hunting statistics from a hunter questionnaire distributed after the season.

RESULTS

Francolin Hunting Statistics

The legal season and bag limit for Black Francolin are a 2 month split season, January 1-31 and July 1-31, with a daily bag limit of 5 birds and no season limit. The split season provides bird hunters an opportunity to hunt birds twice and should encourage greater participation and effort than one prolonged two-month season. The July season typically draws heavier hunter participation than the January season as the grasses are shorter and less dense and the birds more active at that time of year. Two hunter questionnaires were mailed to license holders during January and after the July bird seasons to obtain information on hunting activity. Of the 506 licenses sold, an estimated 414 persons actively hunted actively hunted during the FY 84 general hunting season.

Black Francolin hunting does not draw as large a hunter participation as does the big game hunting season with only 16% of the active hunters reporting they hunted francolin during the January season and 29% reporting they hunted during the July season (Table 1). Hunter success was high 72% in January and 67% in July with a harvest of 2.46 and 4.36 birds per successful hunter in January and July respectively, slightly below the 5.0 bird average for FY 83. Francolin hunters hunted an average of 2.9 and 3.6 days per season in January and July 1984 versus 3.7 days in FY 83. The hunting effort expended per bird harvested increased in FY 84, 1.12 hunter days were expended per bird harvested in FY 83 versus 1.63 and 1.24 hunter days per bird during the January and July season in FY 84.

Estimates of total hunter participation, effort, and harvest were derived from the returned questionnaires. Based on those questionnaires an

Table 1. Island-wide Black Francolin (BLFR) Hunt Statistics for FY 1984.

		Jan 84	July 84	Total
a.	Total license sales for year.	-	-	506
b.	Number of hunter questionnaires returned	144	88	-
c.	Percent of license buyers reporting	28.4%	17.4%	-
d.	Number of reporting license buyers that hunted any species	113	72	-
e.	Percent of license buyers that hunted FY 84	78.5%	81.8%	-
f.	Estimated total number of legal hunters FY 84	397	414	414
g.	Number of reporting hunters that hunted BLFR	18	21	-
h.	Percent of reporting hunters that hunted BLFR	15.9%	29.2%	-
i.	Number of successful BLFR hunters	13	14	-
j.	Hunter success	72.2%	66.7%	-
k.	Number of BLFR taken by reporting hunters	32	61	-
l.	Average number of BLFR taken per hunter	1.78	2.90	-
m.	Average number of BLFR taken per successful hunter	2.46	4.36	-
n.	Estimated total number of legal BLFR hunters	63	121	121
o.	Estimated total legal BLFR harvest	112	351	463
p.	Reported number of days spent hunting	52	76	128
q.	Average number of days spent hunting	2.9	3.6	-
r.	Estimated total number of days spent hunting	183	436	619
s.	Number of days spent hunting per BLFR taken (r ÷ o)	1.63	1.24	1.34
t.	Number of BLFR taken per day hunting (o ÷ r)	0.61	0.81	0.75

estimated 63 hunters spent 183 days hunting francolin during the January season and harvested an estimated 112 birds. Hunter participation increased during the July season with an estimated 121 hunters spent 436 days hunting francolin and harvested 351 birds. For the year total an estimated 619 hunter days were spent and 463 birds harvest, a large increase over the 130 hunter days spent hunting and 116 birds harvested in FY 83.

Dandan once again was by far the most popular area to hunt Black Francolin on island with 94% of francolin hunters reporting they hunted there during the January hunt and 95% reporting they hunted Dandan during the July hunt, up from the 83% hunter participation in FY 83. Dandan also accounted for 90% and 86% of the hunting effort during the January and July seasons, respectively, and 91% and 97% of the harvest , respectively. Tarzan Falls Conservation Reserve and private land were the only areas reported as hunted for francolin.

Hunters were also asked about their hunting habits; hours hunting per day, number of daily limits shot, number of birds lost and if they hunted with a bird dog. The responding hunters reported they hunted an average of 4.0 hours per day in both the January and July season, only one daily limit of 5 birds was reported, and only one person reported hunting with a bird dog. During the January season, reporting hunters lost 14 birds versus 32 harvested, a 44% crippling loss, and during the July season hunters lost 21 birds versus 61 harvested, a 34% crippling loss.

The estimated hunter participation, effort, and harvest seemed far higher than actual francolin hunting activity. The hunter questionnaire derived figures seemingly greatly over-estimated the actual hunter participation, effort, and harvest. The inflated estimates can probably be traced to the fact that successful hunters report their hunting history more readily than unsuccessful hunters. Consequently, responses of successful hunters are over-represented in the survey of hunter activities.

Call Count Surveys

Monthly call count surveys were continued in the Dandan, Pulantat, and Talofofo areas of southern Guam. It is assumed that the trend in numbers of calling males or other francolin observed per survey from year to year provides an accurate index of population trend from year to year.

No dramatic increase in francolin numbers were observed in FY 84 as occurred in FY 83 (AWR 1983). The annual mean number of calling males remained the same at 5.5 birds per station in both FY 83 and FY 84 with no significant difference in population trend between years (Mann-Whitney U-Test, $U=104.5$ $P < 0.20$). Likewise, while there was no significant difference between counts in FY 83 and FY 84 for the Pulantat area (Mann-Whitney U-Test, $U-47$, $P < 0.20$), the annual mean number of birds per station increased slightly from 4.9 to 5.4 birds per station in FY 84. Only Talofofo, of the 3 areas surveyed, decreased in numbers. There the annual mean number of birds observed per station decreased from 4.9 birds in FY 83 to 3.4 birds in FY 84, a significant decrease (Mann-Whitney U-Test, $U=67$, $P < 0.10$).

Table 2. Mean number of Black Francolin observed per station on surveys during FY 1984 in three areas of southern Guam.

AREA	Count No.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Mean	S.D.	C.V.
Dandan	1	3.7	6.3	5.5	8.4	3.8	6.0	4.7	5.8	7.5	3.5	5.4	2.8			
	2	8.8	5.5	7.5	3.8	7.0	4.3	-	7.7	6.8	3.5	6.8	0.0	5.5	2.0	36%
	3	-	-	-	-	4.9	-	-	-	6.4	-	-	-	n=25		
	$\bar{x}$	6.3	5.9	6.5	6.1	5.2	5.1	4.7	6.7	6.9	3.5	6.1	1.4			
Pulantat	1	2.7	5.1	5.1	6.5	7.0	5.4	2.8	7.7	6.5	4.9	-	-	5.4 n=10	1.7	31%
Talofofo	1	2.3	0.5	4.8	-	-	3.1	4.9	4.3	4.2	5.5	1.0	-	3.4 n=9	1.8	53%

Dandan appears to support the highest densities of francolin on island. The highest single count was recorded in Dandan in October 1983 with an average of 8.8 birds counted per station. The January and July hunt did not appear to deplete the population to any great extent. High counts exceeding the annual mean were recorded after both seasons. It appears the Black Francolin can withstand the hunting pressure at its current level.

RECOMMENDATIONS

1. Continue monthly surveys of Black Francolin in Dandan.

2. Collect and compile data on age and sex ratios, reproductive status and food habits of birds examined at hunter check stations throughout the 1984 Black Francolin hunting season.

3. Make pre and post hunting season surveys of popular BIFR hunting areas to determine the effect of hunting.

4. Make quarterly collections of both sexes to collect data on reproductive status, age ratios, and food habits.

LITERATURE CITED

Aquatic and Wildlife Resources Division. 1983. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.H. Freeman Company. San Francisco. 859p.

Report prepared by: Paul Conry

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Survey and Inventory of Native Land Birds on Guam.

PERIOD COVERED: October 1, 1983 to September 30, 1984.

SUMMARY

Results of a rail survey, transect count and roadside counts indicates a continuation of the rapid decline of Guam's native forest birds. The Bridled White-eye has not been seen on Guam since the summer of 1983. Only two Guam Broadbills and 5-6 Rufous-fronted Fantails have been seen since the summer of 1983. The last remaining continuous population of Guam Rails numbering approximately 20 individuals is located inside the flightline on Andersen AFB. Except for the Guam Rail, Guam's native forest birds now are located primarily on Northwest Field, Andersen Air Force Base. Seven native birds were listed on the Federal Endangered Species List.

BACKGROUND

Since the early 1960's, census data has documented the decline in both range and numbers of Guam's native land birds. Roadside counts initiated in 1960 over three routes in central and northern Guam by the Guam Division of Aquatic and Wildlife Resources (DAWR) have provided an index to the decline (DAWR, 1974-1983). From 1979 to 1981 estimates of population size were made by the DAWR based on variable circular plot technique (Reynolds et al, 1980) from station counts in central and northern Guam (DAWR, 1980-1982). From June to July of 1981, an intensive forest bird survey utilizing variable-circular plot techniques along randomly located transects were conducted by the U.S. Fish and Wildlife Service with the cooperation of the DAWR (Engbring, Unpublished manuscript). Some of these transects have been repeated in recent years by the DAWR (DAWR, 1982).

Native land birds are now restricted to extreme northern Guam, primarily at Andersen Air Force Base (AAFB) and surrounding cliffline areas. Exceptions are the Vanikoro Swiftlet (now apparently restricted to one cave in central Guam), Marianas Gallinule (found over most of Guam in restricted and declining wetlands), Micronesian Starling (also found on Cocos Island) and the Yellow Bittern (declining but found in savannah and second-growth vegetation over the entire island (DAWR, 1974-1983).

A captive breeding program for the Guam Rail and Guam subspecies of the Micronesian Kingfisher was successfully begun in 1983. The Guam Rail is now breeding in captivity both on Guam and at the Conservation and Research Center of the National Zoological Park, in Front Royal, Virginia. The Kingfisher is now at 4 zoos on the mainland (Philadelphia, Bronx, National, and Denver), but as yet has not bred in captivity.

OBJECTIVES

To monitor population trends of the native land birds on Guam.

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes in northern Guam (Figure 1). These routes were driven at approximately 6-9 km per hour beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.

2. The Pajon Basin (East Ritidian Point) variable circular plot transect was surveyed by DAWR personnel in May (Figure 2). This transect has been run on an irregular basis since September of 1981. Prior to censusing, personnel received training in distance estimation and species identification to ensure comparable data collection. Stations were premarked and placed 150m apart along the transects to minimize the possibility of observing the same birds from different stations. Stations were censused using the eight minute variable circular-plot techniques as described by Reynolds et. al. (1980).

3. A resurvey for Guam Rails of much of the area covered in the November-December 1982 (DAWR, 1983) was done in March 1984 (See Fig. 3). Areas that did not contain rails in 1983 were not resurveyed in 1984. Tape recorded calls of the rail were played at approximately 150 m intervals for 2 minutes along roads and runways on Andersen Air Force Base and adjacent areas. All responses were recorded.

RESULTS

Roadside Counts

Roadside count results are shown on Tables 1,2,3 and summarized on Table 4. In fiscal year 1983 the Micronesian Starling, Marianas Crow and Guam Broadbill (one sighting) were the only native forest birds seen on the North (Table 1. DAWR, 1983) and North Central (Table 2. DAWR, 1983) roadside counts. During fiscal year 1984, the Marianas Crow (two sightings) and the Rufous-fronted Fantail (one sighting) were the only native forest birds seen on these same census routes. With the exception of these, the migratory Pacific Golden Plover, and the Yellow Bittern, only introduced bird were seen on these two roadside counts. Northwest Field (Table 2) is now the only roadside count with native forest birds and these are declining.

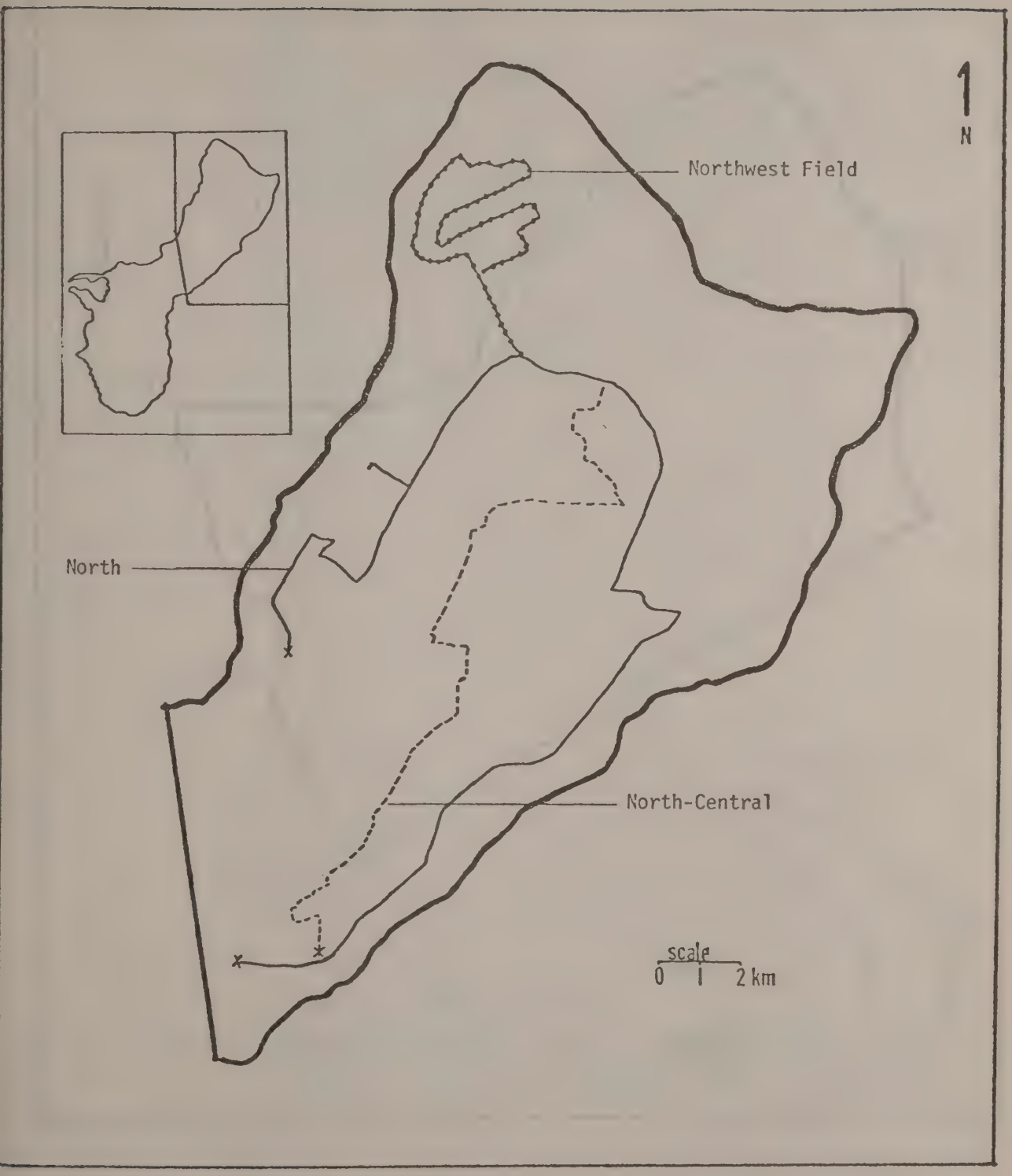

Figure 1. North, North-Central and Northwest Field roadside bird census routes along paved and unpaved roads.

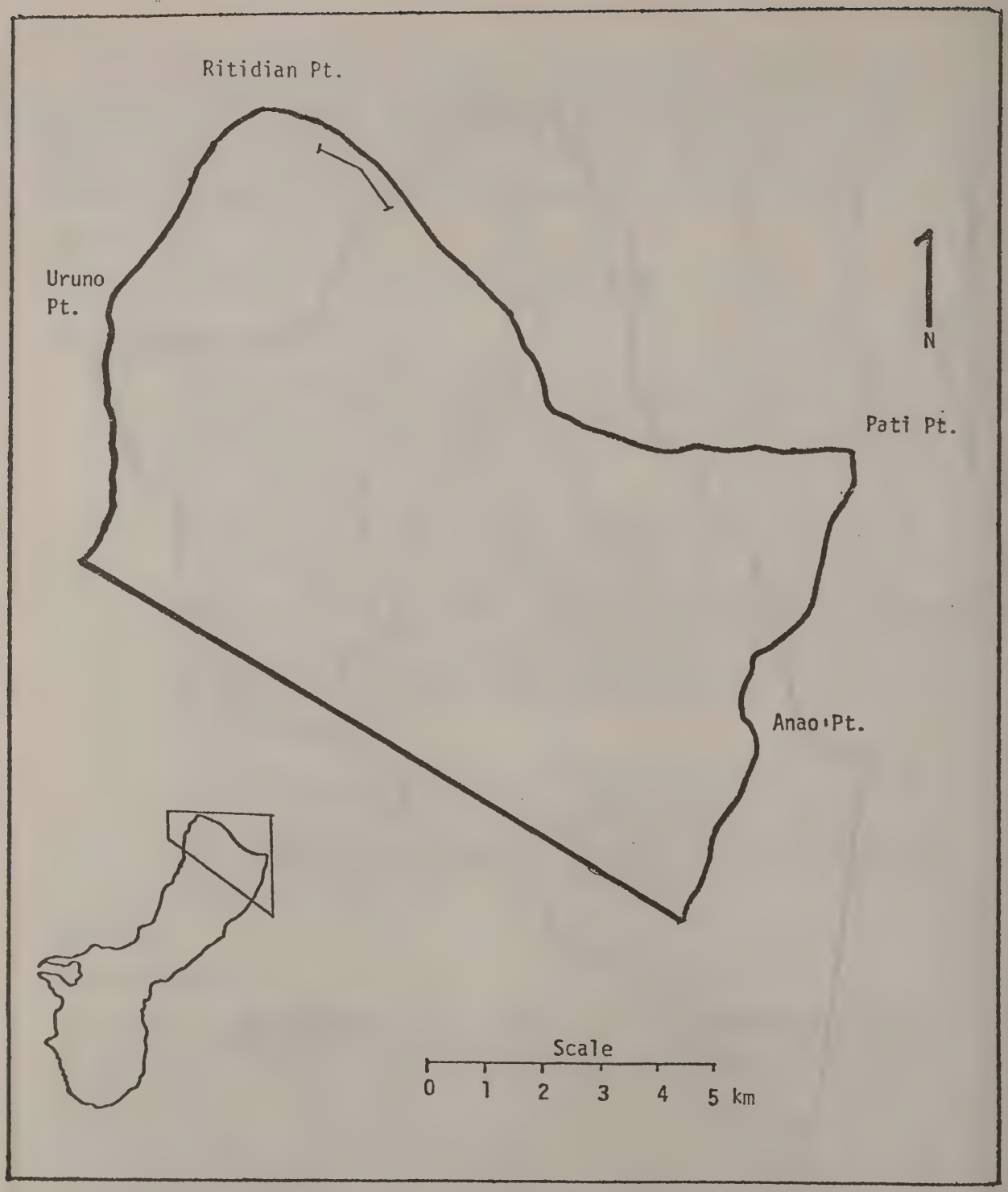

Figure 2. Location of Pajon Basin (East Ritidian Point) transect.

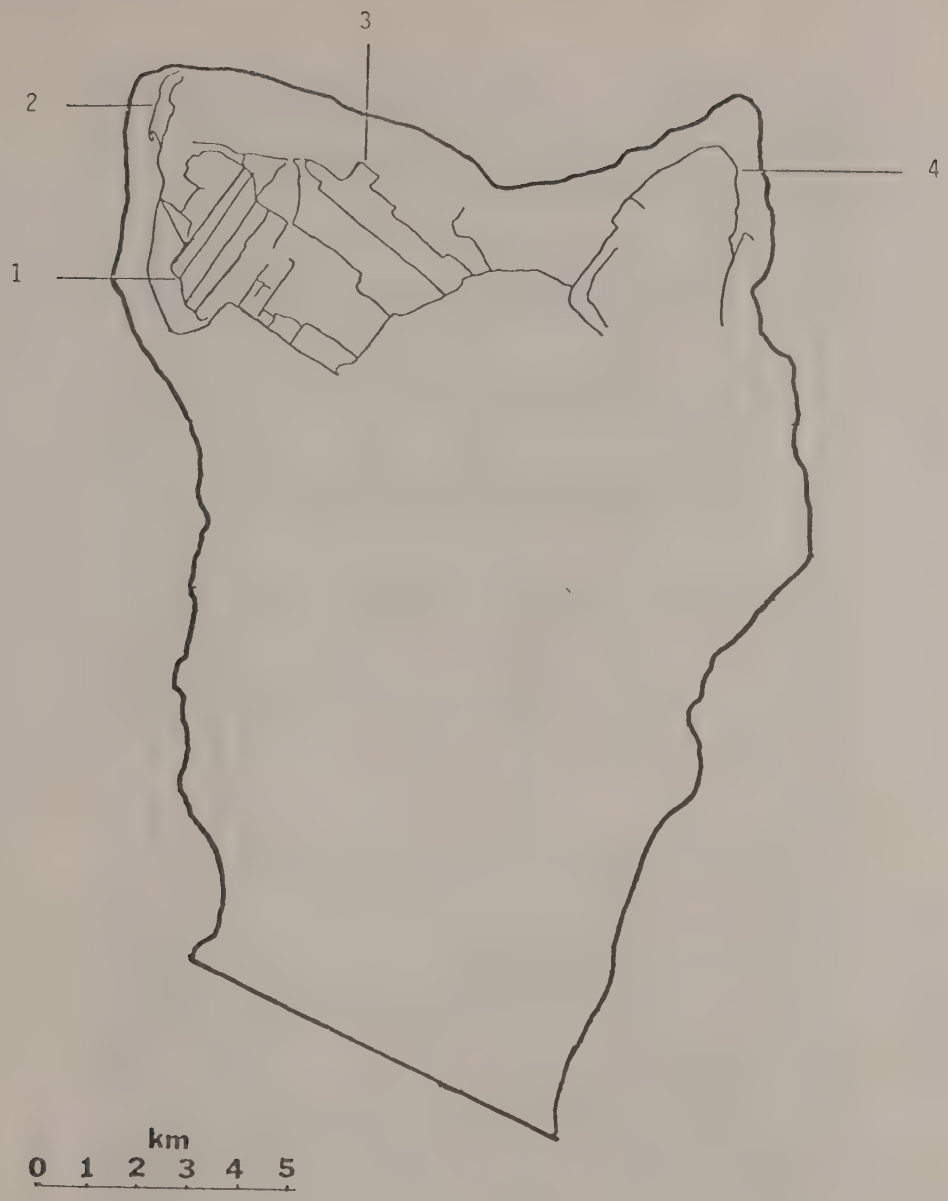

Figure 3. Location of March 1984 survey route for the Guam Rail. The numbers correspond to the following areas: 1-Northwest Field, 2-Ritidian, 3-Andersen Conventional Weapons Area, 4-Andersen Air Force Base.

Table 1. Average number of birds per 100 Km observed each month on the North roadside count during Fiscal Year 1984.

Species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X/COUNT	X/100 km
Yellow Bittern	3.3	5.0	2.8	9.4	3.8	5.0	6.6	2.8		1.3	4.0	0.0	30	1.5	4.2
Marianas Crow	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	2	0.1	0.3
Black Drongo	14.9	38.1	11.4	28.0	15.3	22.1	15.8	20.8		30.2	34.7	25.5	170	8.5	23.7
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Marianas Fruit Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Guam Broadbill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Golden Plover	208.6	109.3	51.1	100.3	101.0	60.3	77.5	0.0		0.0	16.0	39.7	473	23.7	66.0
White-throated Ground Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Cardinal Honeyeater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Micronesian Kingfisher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Noddy Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
P. T. Dove	11.6	14.9	5.7	13.4	0.0	22.6	13.1	11.4		3.9	5.3	14.2	71	3.6	9.9
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Guam Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Chestnut Mannikin	0.0	0.0	19.9	0.0	0.0	0.0	0.0	2.8		0.0	0.0	0.0	10	0.5	1.4
Eurasian Tree Sparrow	14.9	0.0	0.0	20.0	11.5	10.0	6.6	0.0		0.0	6.7	0.0	47	2.35	6.6
Micronesian Starling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
White Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0	0.0	0.0
Km	60.4	60.4	35.2	74.8	78.2	39.75	76.1	105.6		76.0	74.8	35.24	716.5	38.2	6.9
Miles	37.5	37.5	21.9	46.5	48.6	24.7	47.3	66.0		42.7	46.5	21.9	398.9	23.7	4.3
Counts	2	2	1	2	2	1	2	3		2	2	1	20		

Table 2. Average number of birds per 100 Km observed each month on the North-Central roadside count during Fiscal Year 1984.

Species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X/COUNT	X/100 km
Yellow Bittern	5.8	5.8	5.3	12.9	5.3	7.8	11.4	0.0	0.0	0.0	4.9	7.2	30	1.3	6.7
Marianas Crow	0.0	0.0	0.0	10.3	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	10	0.4	2.0
Black Drongo	45.9	11.5	63.8	36.2	21.1	36.5	44.3	123.9	19.8	0.0	12.2	26.5	214	9.3	44.38
Rufous-fronted Fantail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	2	0.1	.4
Marianas Fruit Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	1	0.0	0.2
Guam Broadbill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Golden Plover	829.7	924.9	672.9	532.2	419.3	440.1	398.4	1.3	0.0	0.0	133.8	98.8	1504	65.39	362.69
White-throated Ground Dove	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Cardinal Honeyeater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	2	0.1	.4
Micronesian Kingfisher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	5	0.22	1.1
Noddy Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
P. T. Dove	64.9	17.3	29.2	25.8	5.3	18.2	23.4	67.0	34.8	10.3	41.4	26.5	156	6.78	34.9
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Guam Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Chestnut Mannikin	0.0	0.0	0.0	0.0	0.0	0.0	15.6	0.0	0.0	0.0	0.0	0.0	6	0.26	1.3
Eurasian Tree Sparrow	27.0	0.0	0.0	18.0	18.5	18.2	0.0	13.9	5.0	20.7	24.3	12.0	62	2.70	13.9
Micronesian Starling	5.4	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	5.2	0.0	0.0	6	0.26	1.3
White Tern	0.0	0.0	2.7	0.0	18.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8	0.35	1.8
Km	37.0	17.3	37.6	38.7	37.9	38.4	38.4	79.1	20.2	19.3	41.1	41.5	446.5	0	0
Miles	23	10.8	23.4	24.1	23.7	23.9	23.9	49.2	12.6	12.0	25.6	25.8	278.0		
Counts	2	1	2	2	2	2	2	3	1	1	2	2	22		

Table 3. Average number of birds per 100 Kg observed each month on the Northwest Field roadside count during Fiscal Year 1984.

Species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	TOTAL	X/COUNT	X/100 km
Yellow Bittern	12.0	5.4	11.2	-	17.3	8.7	-	1.9	14.5	4.3	11.1	15.9	30	1.7	9.9
Marianas Crow	43.4	21.6	33.5	-	37.5	20.3	-	22.3	20.2	4.3	86.0	21.2	99	5.8	32.5
Black Drongo	480.4	54.0	541.8	-	673.4	401.2	-	344.1	739.9	480.7	326.9	111.1	1330	78.2	439.1
Rufous-fronted Fantail	3.0	0.0	0.0	-	2.9	5.8	-	5.6	2.9	0.0	0.0	0.0	8	0.5	2.7
Marianas Fruit Dove	3.0	0.0	5.6	-	2.9	0.0	0	1.9	5.8	0.0	5.5	0.0	9	0.5	2.7
Guam Broadbill	0.0	0.0	0.0	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Golden Plover	114.2	270.3	156.4	-	2.9	2.9	-	1.9	17.3	0.0	0.0	169.5	157	9.2	51.6
White-throated Ground Dove	0.0	0.0	5.6	-	2.9	0.0	-	3.7	0.0	0.0	2.8	0.0	5	0.3	1.7
Cardinal Honeyeater	15.0	0.0	5.6	-	14.5	26.1	-	13.0	0.0	0.0	0.0	0.0	27	1.6	8.9
Micronesian Kingfisher	6.0	10.8	5.6	-	20.2	23.2	-	11.1	7.5	0.0	5.5	0.0	29	1.7	9.5
Noddy Tern	0.0	0.0	0.0	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
P. T. Dove	90.1	54.0	268.2	-	124.2	185.8	-	245.6	136.4	81.4	235.8	111.2	534	31.4	175.23
Chinese Painted Quail	0.0	0.0	0.0	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0
Guam Rail	3.0	0.0	0.0	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	1	0.1	0.3
Chestnut Mannikin	3.0	0.0	0.0	-	0.0	8.7	-	0.0	0.0	0.0	5.5	0.0	6	0.4	2.0
Eurasian Tree Sparrow	15.0	54.0	0.0	-	0.0	0.0	-	9.3	11.6	4.3	0.0	0.0	25	1.5	8.2
Micronesian Starling	43.4	10.8	16.8	-	31.8	31.9	-	9.3	8.7	0.0	30.5	10.6	62	3.7	20.4
White Tern	0.0	0.0	11.2	-	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	2	0.1	0.7
Km	33.28	18.5	17.9	-	34.6	34.4		53.8	34.6	23.3	36.0	18.88	304.6		
Miles	20.8	11.5	11.2	-	21.5	21.4		33.6	21.5	14.5	22.4	11.8	190.4		
Counts	2	1	1	-	2	2		3	2	1	2	1	17		

Table 4. Results of Northwest Field, North, and North Central roadside counts showing the mean number of birds per 100 Km of travel, the standard deviation (σ) and the coefficient of variation (CV).

Species	Northwest Field FY			North FY			North-Central FY		
	X	σ	CV	X	σ	CV	X	σ	CV
Yellow Bittern	9.9	5.2	52.5	4.2	2.4	58.4	6.7	3.7	56.6
Marianas Crow	32.5	22.3	68.61	0.3	1.0	307.8	2.2	3.8	191.5
Black Drongo	439.1	352.9	56.0	23.7	8.5	35.8	47.9	36.1	81.5
Rufous-fronted Fantail	2.7	2.3	85.2	0.0	0.0	0.0	0.4	0.9	257.6
Marianas Fruit Dove	2.7	2.2	81.5	0.0	0.0	0.0	0.2	0.5	257.6
Guam Broadbill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Golden Plover	5.6	82.0	158.9	66.0	63.7	68.5	336.8	302.5	83.4
White-throated Ground Dove	1.7	1.8	94.4	0.0	0.0	0.0	0.0	0.0	0.0
Cardinal Honeyeater	8.9	9.2	103.37	0.0	0.0	0.0	0.4	0.9	257.5
Micronesian Kingfisher	9.5	7.3	76.84	0.0	0.0	0.0	1.1	2.2	257.6
Noddy Tern	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Philippine Turtle Dove	175.3	73.2	41.8	9.9	5.7	56.6	34.9	20.4	61.4
Chinese Painted Quail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Guam Rail	0.3	1.0	333.3	0.0	0.0	0.0	0.0	0.0	0.0
Chestnut Mannikin	2.0	3.2	158.2	1.4	4.5	315.8	1.3	4.6	323.7
Eurasian Tree Sparrow	8.2	13.2	161.0	6.6	7.1	109.1	13.9	9.2	66.6
Micronesian Starling	20.4	13.8	67.6	0.0	0.0	0.0	1.3	2.1	170.3
White Tern	0.7	2.7	385.7	0.0	0.0	0.0	1.8	5.4	281.3

The Pajon Basin count (Fig. 2), which in the Spring of 1983 was the last area known to have all the native forest birds still present (DAWR, 1983), showed a precipitous drop in the numbers of native forest birds (Table 5). By May 15, 1984 the Marianas Fruit Dove, Rufous-fronted Fantail, Guam Broadbill, and Bridled White-eye were no longer found in the area. The Bridled White-eye has not been seen anywhere on Guam since a sighting by DAWR staff in Pajon Basin on July 1984. The last known sighting of the Rufous-fronted Fantail was in Northwest Field in June 1984. The last two sightings of the Guam Broadbill were apparently transient individual males. One was seen by DAWR staff and Dr. Eugene Morton, Smithsonian Institution in Northwest Field in March 1984 and the other was seen by Philip Bruner, Brigham Young University in an area adjacent to the Navy Golf Course in Barrigada in September 1984. Recent observations by DAWR staff in the Pajon Basin area in September 1984 indicate that virtually all species are now gone from that area except for occasional crows. This leaves Northwest Field as the primary area that still contains native forest birds on Guam (See Northwest Field roadside count, Table 3).

A repeat of the Guam Rail census done in January 1983 (DAWR, 1983) in March 1984 by DAWR staff and Dr. Eugene Morton, Smithsonian Institution (Fig. 3) showed an 80% decline in rail sightings from January 1983 to March 1984. By 1984 the only remaining continuous population of approximately 20 rails was located inside the flightline on Andersen Air Force Base. The continuous population found at Ritidian Point during the 1983 census (See Fig. 3, DAWR, 1983) had declined to a few scattered individuals. A few other scattered individuals were found across Northwest Field on Andersen AFB.

Applications for federal Fish and Wildlife (Endangered Species) Permits to cover ongoing activities were submitted in November, 1983 in anticipation of federal endangered species listing of several species of Guam's native birds. The Guam Rail was "emergency listed" on April 11, 1984, and an Endangered Species Permit to cover our rail activities was issued on June 15, 1984. The Guam Rail, Marianas Gallinule, Vanikoro Swiftlet, Guam subspecies of the Micronesian Kingfisher, Guam population of the Marianas Crow, Guam Broadbill and Guam subspecies of the Bridled White-eye were formally listed as endangered on August 27, 1984, and a permit was issued October 15, 1984.

RECOMMENDATIONS

1. Continue bi-monthly roadside counts over the three routes in northern Guam.

2. Continue playback census of the Guam Rail in its remaining range.

3. Initiate quarterly census of the Marianas Crow in order to estimate population size on Guam.

4. Initiate survey of native forest birds using variable circular plot techniques in Northwest Field and Conventional Weapons Storage Area on AAFB.

Table 5. Pajon Basin - Transect Count Summary

	6/18/81*	6/2/82	5/19/83	6/28/83	7/28/83	8/31/83	9/30/83	10/27/83	12/5/83	5/15/84
Guam Rail	0	0	0	0	0	1	0	0	0	0
Marianas Fruit Dove	5.5	9.5	2	1	1	2	0	0	0	0
Philippine Turtle Dove	0	0	0	3	2.5	15.5	21.5	10.5	17	9.5
White-throated Ground Dove	.5	1.5	4.5	1	0	4	1.5	1.5	1.5	2.5
Micronesian Kingfisher	14.5	8.5	12	23	18	15.5	18	9.5	20	13
Marianas Crow	14	16.5	18.6	28	25.5	25	20	26.5	32.5	18
Rufous-fronted Fantail	36.5	27.5	22	21.5	6	2	2	1.5	0	0
Guam Broadbill	3	11.5	2.5	8.5	10.5	8	6	1	0	0
Micronesian Starling	76	79.5	71.5	63	75	61	48.5	51	41	35.5
Cardinal Honeyeater	15.5	16.5	15.5	17	17	9	9.5	15	4	1
Bridled White-eye	54	49	1.5	0	0	0	0	0	0	0

Above are average total number of birds counted by 2 observers at ten stations at Pajon Basin (East Ritidian Pt.), Guam from September 1981 to May 1984.

*1981 survey was conducted by U.S.F.W.S. and GAWR staff. 1982 to 1983 was conducted by GAWR staff.

5. Establish a working agreement with the Division of Fish and Game, Commonwealth of the Northern Marianas to monitor the population size of the Marianas Crow on Rota.

6. Develop and implement methods for control of the brown tree snakes.

7. Continue efforts to captive breed endemic endangered native land birds on Guam and at stateside zoos.

8. Continue natural history and breeding biology studies of the native avifauna.

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Report prepared by: Robert Beck, Jr.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: The current status, distribution and natural history of Marianas fruit bats.

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Guam's fruit bat population is currently estimated at 400 to 470 animals. Three known incidents of illegal hunting of bats occurred during the year. In FY 1984, 16,252 frozen fruit bats were imported to Guam from other islands for human consumption, an increase of 26% over the previous year. A survey of 29 caves failed to locate any sheath-tailed bats.

BACKGROUND

The Marianas fruit bat (Pteropus mariannus mariannus) is endemic to the Mariana Islands and has been under investigation by the Aquatic and Wildlife Resources Division (AWRD) of Guam since 1962 (AWRD 1964-1983). These bats, considered a delicacy by Chamorro residents, steadily declined in number during the 1960's (Perez 1972). Thereafter, annual surveys revealed that only a few dispersed, solitary bats remained in the prime habitat on Guam which once supported colonies containing hundreds of bats (Wheeler and Aguon 1978, Wheeler 1979). Reasons for the decline included: increased human population pressures that resulted in over-hunting and permanent habit destruction, commercial exploitation of this food species, periodic severe typhoons, the lack of an adequate enforcement staff, and delays by the local legislature in passing protective legislation (Wheeler 1979). Fruit bats finally received full legal protection in 1973 and in 1981, they were placed on Guam's territorial Endangered Species List. Fruit bat abundance began to increase in 1980 and by 1982, Guam's population had grown to an estimated 850 to 1,000 animals. However, in 1983, poaching caused numbers to fall to about 600 to 775 animals. Both the Marianas fruit bat and the little Marianas fruit bat (P. tokudae) were placed on the U.S. Endangered Species List on August 27, 1984.

OBJECTIVES

To monitor the population size and study the natural history of the Marianas fruit bat in the Mariana Islands.

PROCEDURES

1. Continue the systematic survey of fruit bat distribution and numbers initiated on Guam in 1978 and in the Commonwealth of the Northern Mariana Islands (CNMI) in 1979.

    a. Conduct annual surveys of Guam's northern cliffline with periodic surveys in other areas.

        1. Record bat numbers observed and search for additional bat colonies.

        2. For each bat observed record (where possible and applicable) flight elevation and direction, roosting tree species and height, part of plant eaten (flower, fruit, leaves, etc.), height in forage tree, sex and age (if possible), other behavior such as vocalization, copulation, etc.

    b. Conduct weekly intensive observations of bat colonies.

2. Monitor fruit bat imports to Guam from other islands in Micronesia and the Pacific.

3. Maintain close liaison with CNMI Fish & Game Staff as well as other bat researchers and with government officials in other island groups as well as on Guam.

RESULTS

Bat Surveys on Guam

An island-wide survey of fruit bats was conducted from 14 February to 16 April 1984. Searches for bats were made from hill tops, cliffs and beaches that overlooked 20.21 km^2 of forest and from 13.5 km of forest trails. Bats were recorded at only 11 locations, all in northern Guam and most on Andersen Air Force Base. At the time, the island's single large harem-containing colony inhabited a site 800 m southeast of Mergagan Point. Three hundred six bats were counted in this roost but 335 to 370 adults were estimated to be present. Previous observations of this colony at other roost sites indicated that it had a sex-ratio highly skewed toward females (37.5 males:100 females) and a mean of 18.3% of the females with unweaned young (Wiles unpubl. data). Thus, the colony were estimated to include 40 to 50 young and 375 to 420 total animals. Several small groups of bats were also observed. A small bachelor male roost at North Pati Point had 23 bats visible (estimate of 25 to 30 individuals) while a second group at Jinapsan Point, possessing several bachelors and one small harem, had 9 bats visible (estimate of 10 to 12 individuals). Elsewhere between Mergagan Point and Achae Point, individuals and several small groups of 2 to 4 animals were seen or heard.

No bats were recorded along the island's eastern or western coastlines, at Mt. Barrigada or from southern Guam. Similarly during 15 hr of searching for gray swiftlets (Collocalia vanikorensis) in the south in May and June

1984, C.F. Aguon (pers. comm.) also failed to observe any fruit bat. However, because of rare recent sightings by residents in of these regions, fewer than 50 bats total probably still inhabit these areas.

A week after the survey ended, poachers raided the Mergagan Point colony and killed probably 40 to 50 animals. Over 40 expended shotgun shells were found at the site. Thus, Guam's population of P. m. mariannus is estimated at approximately 400 to 470 animals. This is lower than the FY 1983 figure of 600 to 775 animals (AWRD 1983). A manuscript describing the survey and its results in greater detail will be submitted for publication during the next fiscal year.

Bat Imports

Import permits are required for all shipments of fruit bats entering Guam. There is currently no limit to the number of bats that can be requested on a single permit and retail merchants frequently inflate requests to cover the possibility that a large number of bats may be available at their supply source. During FY 1984 ,82,933 bats were requested for import (Table 1), an increase of more than double (111%) from the previous year (AWRD 1983).

A total of 16,252 frozen fruit bats in 96 shipments were actually shipped to Guam from other islands in FY 1984 (Table 2). This represents a rise of 26% over the previous year and is the second consecutive year that importations have increased (AWRD 1983).

Western Samoa and Palau were the major sources of bats for the Guam market in FY 1983, accounting for 66% of all imported bats (Table 2). Palau became an important suppliers again, exporting 4,025 bats in 57 shipments during FY 1984 as compared with 1,105 animal in 7 shipments in FY 1983. Islands within Micronesia shipped 4,396 bats to Guam (27% of the total). Guam's largest retailer of bats imported 70% of all animals brought to the island, accounting for all but 492 of the bats shipped in from Western Samoa, Tonga, American Samoa and New Guinea. A manuscript describing the fruit bat trade on Guam in greater detail will be submitted for publication during the next fiscal year.

Illegal Hunting

Poaching continues to be probably the major factor preventing a recovery of Guam's fruit bat population. Three known cases of illegal hunting occurred in FY 1984. A resident of Jinapsan Beach heard about six shots fired on a moonlit evening along the top of the cliff near Jinapsan Point in early October. On 6 December at 0930, 20 to 30 gunshots were heard from the colony site at the bottom of the cliff between Pajon and Jinapsan Points. A final incident occurred on about 10 April when hunters visited the colony at its roost above Tarague Beach, forcing the bats to abandon the site. Forty-two empty shotgun shells were later collected under the empty roost.

Insectivorous Bats

During the year, 29 caves were searched for the presence of Emballonura semicaudata but no bats were found. E. semicaudata has not been seen on

Table 1. Number of frozen fruit bats requested for import to Guam between October 1, 1983 and September 30, 1984.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total	No. of Permits Issued
Western Samoa	2,000	1,200	3,000	1,500	3,000	3,500	2,000	3,150	1,800	1,500	2,000	1,100	25,750	46
American Samoa	75	150	625	7,530	50	3,032	2,200		3,150	1,500	2,000	1,000	21,312	38
Palau	200	2,780	1,442	583	610	796	962	1,110	465	1,195	1,223	832	12,198	147
Tonga	1,500	1,500	1,000	2,000	1,500	2,000	2,100						11,600	19
New Guinea										1,500	2,000	1,000	4,500	9
Truk		86	575	50	500	2,500				50	60	500	4,421	15
Kosrae						1,000	1,050						2,050	3
Ponape		150	130	120		150	160	60	85	175		60	1,090	25
Vanuatu									12				12	1
TOTAL	3,875	5,866	6,772	11,783	5,660	12,978	8,472	4,320	5,512	5,920	7,283	4,492	82,933	303

Table 2. Number of frozen fruit bats imported to Guam between October 1, 1983 to September 30, 1984.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	No. of Permits Received
Western Samoa	500		475	1,000	478	500	1,496	2,000		200			6,649	12
Palau	300	1,090	867	31	40	478	395	285	260	130	85	64	4,025	57
Tonga	530	1,000		500									2,030	4
American Samoa	75	62	100	1,000		55			50		190	100	1,632	9
New Guinea										39	1,000	500	1,539	6
Ponape		25	50	50			150			69			344	7
Kosrae								27					27	1
Vanuatu									12				12	1
TOTAL	1,045	2,177	1,492	2,581	518	1,033	2,041	2,312	322	438	1,275	644	16,258	97

Guam since May 1972 (AWRD 1976:111) but has recently been rediscovered on Aguijan in the CNMI (T.O. Lemke, pers. comm.). A final report summarizing the cave surveys will be written in FY 1985 provided that manpower is adequate. A manuscript describing the discovery of a carcass tentatively identified as Myotis lucifugus on AAFB (AWRD 1983) has been submitted for publication.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may prove to be productive since continued poaching at bat roosts on Rota (T.O. Lemke, pers. comm.) could cause large numbers of bats to move to Guam.

2. Continue to make observations at Guam's bat colonies. Information should be gathered on reproductive biology, behavior within the colonies, and the sex and number of bats present.

3. Known bat roosting areas should be patrolled regularly by Conservation Officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching is a serious problem.

4. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a relatively large bat population is found but where logistics prevent the CNMI from doing extensive field work. Emphasis of this project would be to identify colonies should they move between Guam and Rota.

5. Continue to monitor fruit bat imports entering Guam. Export permits or certificates of origin should continue to be required for all shipments to ensure that the bats have been legally harvested, that the place of origin is known, and that the government authorities at the place of origin are aware of the drain on their resources.

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Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 3

JOB TITLE: Movement patterns and habitat utilization of Marianas fruit bats.

PERIOD COVERED: October 1, 1983 to September 30, 1984.

SUMMARY

Eight roosts were used by colonies of Marianas fruit bats (Pteropus mariannus mariannus) during the year. Poaching incidents caused the abandonment of at least two of these sites. Fidelity of bats to former roosting sites appears to be low.

BACKGROUND

Little is known about the movements and habitat use of Marianas fruit bats on Guam. Low population levels and the tree-dwelling habits of bats have made capture attempts and banding studies impractical. In the past, most information on movements has come from incidental sightings and reports from local citizens (Perez 1972). Knowledge of movements, particularly between islands, is necessary in formulating proper cooperative management measures for bats in Guam and the Commonwealth of the Northern Marianas.

PROCEDURES

1. Develop methods and techniques for capturing, marking and instrumenting fruit bats.
    a. Develop and test marking, banding or tagging methods.
    b. Develop and test methods of instrumenting bats with radio-telemetry equipment.
2. Implement a bat banding or marking program.
3. Determine bat movements and activity patterns.
    a. Telemetry study to emphasize roost site fidelity, activity patterns, inter-island migration, and habitat utilization (to be developed).
    b. Record roosting sites of bat colonies and observe activity patterns of bats at them.

4. Determine habitat utilization of bats.

   a. Ordination of habitat in bat feeding areas through multi-variate analysis of telemetry data (to be developed).

   b. Visit colony roosting sites and record the size and abundance of the vegetation present.

RESULTS

Colonies of Marianas fruit bats were observed at eight roosting locations during FY 1984 (Table 1, Figure 1). One of these sites, North Pati Point, has been used for 39 consecutive months (AWRD 1981-1983). In FY 1984, the site was occupied from October to April by 30 to 50 bats, most of which were bachelor males. The main harem-containing colony moved to North Pati Point in April and resided there through September. Twice during the year, portions of the main harem-containing colony separated into two groups that roosted at different locations. On 6 December poaching caused the North Jinapsan Basin (site 1) roost to be abandoned. Part of the colony moved to a roost at North Tarague cliffline (site 2) while the remainder of the bats went to North Jinapsan Point. By 1 February, both groups had rejoined and were occupying the North Tarague site. A second separation occurred on 25 May when a portion of the North Pati Point colony formed a new roost at North Jinapsan Basin (site 2). This splinter group, with about 150 bats, also used North Jinapsan Basin (site 3) and East Ritidian Point as roosts.

As in previous years, the fidelity of fruit bats to former roosts was low. Only two (North Pati Point and North Jinapsan Point) of the eight sites occupied in FY 1984 have been used in the past three years.

RECOMMENDATIONS

1. Delay radio telemetry studies until after the completion of a recovery plan for fruit bats. At present, it is felt that roosting and feeding areas of bats are known well enough to make basic management decisions.

2. Continue regular observations and counts at known fruit bat colonies. Continue to visit colony roost sites after they have been abandoned to record the habitat components present.

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Perez, G.S.A. 1972. Observations of Guam Bats. Micronesica 8:141-149.

Report prepared by: Gary J. Wiles

Table 1. Dates of use of eight roost sites by harem-containing colonies of Marianas fruit bats.

Site	Period Used by Bats
North Pati Point	24 June 1981 to present[1]
North Tarague Cliffline - Site 1	9 July to 10 November 1983
North Jinapsan Basin - Site 1	10 November to 6 December 1983
North Tarague Cliffline - Site 2	6 December 1983 to 11 April 1984
North Jinapsan Point	6 December 1983 to 1 February 1984
North Jinapsan Basin - Site 2	25 May to 3 June 1984
North Jinapsan Basin - Site 3	3 June to 1 July 1984
East Ritidian Point	1 July to present

[1]This site was occupied by a bachelor group until 11 April 1984 when it was joined by the main harem-containing colony.

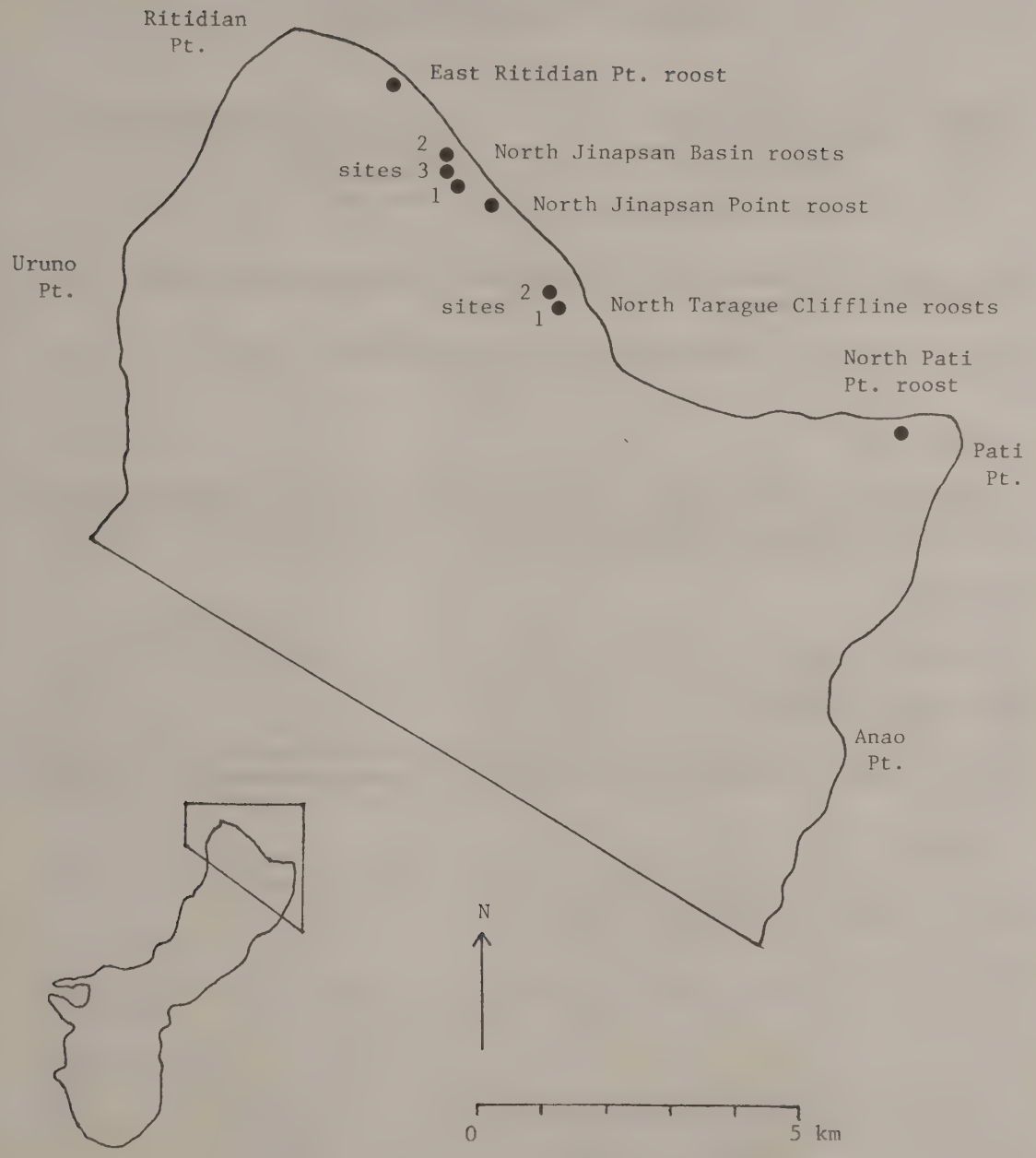

Figure 1. Locations of eight roost sites used by Marianas fruit bats in FY 1984.

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 4

JOB TITLE: Recovery and Management Plan of Marianas Fruit Bats

PERIOD COVERED: October 1, 1983 to September 30, 1984

OBJECTIVES

To summarize available data regarding natural history, population size, distribution and current status and to develop a recovery and management plan for the Marianas fruit bat.

RESULTS

This job was inactive during this segment due to shortage of staff.

RECOMMENDATIONS

This job will be completed in conjunction with Endangered Species Job E-1-3-2 during Segment 22 provided that adequate manpower is made available.

Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 5

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Populations.

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

A study of the impact of avian disease on Guam's bird populations is in progress. A major sentinel study was completed. No obvious diseases capable of extirpating species were discovered during the field phase of the study. Laboratory tests of the samples have not been completed.

BACKGROUND

Guam's native birds have declined drastically in past years, and several species have been recently added to the USFWS Endangered Species List. Introduced diseases have been suggested as a possible cause of the decline. Warner (1968) proposed that extinction of nearly half of the endemic Hawaiian avifauna was due to the pathogenicity of avian malaria, pox, and other possible introduced diseases.

An intensive study of avian disease on Guam is being conducted to determine if disease is the cause of the avian decline.

OBJECTIVE

To determine the presence and impact of avian disease on Guam's bird populations.

PROCEDURES

1. Conduct sentinel studies to determine presence of avian disease.

    a. Collaborative sentinel study between DAWR and the National Wildlife Health Laboratory (NWHL).

        Chickens, quail, and canaries were purchased on the mainland and Bridled White-eyes were trapped on Saipan. White-eyes were the first species to go extinct on Guam and are presumably very susceptible to the factor(s) causing the decline. All birds were shipped to Guam in mosquito-proofed containers. Study sites were located at Pott's Junction and

Ritidian Basin in northern Guam. Although a few native birds are still seen, most species are gone from these areas. Ritidian Basin was the last location on Guam to harbor normal avian populations.

Controls were housed in mosquito-proof cages inside a 2.4x3.7m insect-proof building. Exposed canaries and white-eyes were held in standard bird cages within a 2.4x2.4 m building and exposed chickens and quails were housed in .8x1.2x.5m cages. Exposure cages and buildings had ½ inch hardware cloth walls to prevent snake entry.

Table 1 shows the distribution of sentinel birds according to treatment at the two study sites. Due to mortality in transit, quail were only exposed at the Pott's Junction site.

All birds except the white-eyes were weighed and bled by jugular for serum, PCV, and smear on a weekly basis. Due to their small size, white-eyes were weighed and toe-clipped for blood smears. Every other week, all birds had cloacal swabs for bacteria and viruses. A portion of the birds in each treatment were immunosuppressed with dexamethasone administered by subcutaneous injection. After about 6 weeks of exposure, most birds were exsanguinated, euthanized and examined. Swabs for bacteria and viruses and tissue samples were sent to NWHL for diagnostic examination. Both DAWR and NWHL are examining the blood slides.

2. Supplement study E-1-1-6 (Avian Disease).

RESULTS

The field phase of the sentinel experiment revealed no infectious diseases capable of causing the decline of Guam's birds. However, laboratory tests by the NWHL have not been completed. Avian pox was preliminarily diagnosed in several chickens at the Pott's Junction study site.

RECOMMENDATIONS

NWHL should analyze the samples as soon as possible and DAWR, in cooperation with NWHL, should submit a final report on the study.

LITERATURE CITED

Warner, R.E. 1968. The role of introduced disease in the extinction of the endemic Hawaiian avifauna. Condor 70(2): 101-120.

Report prepared by: Julie A. Savidge

Table 1. Number of birds in the various treatments. P = Protected; X = Exposed; (D) = Number injected with dexamethasone out of total used in the treatment.

	Pott's Junction		Ritidian		Lab	
	P(D)	X(D)	P(D)	X(D)	P(D)	Total
Chickens		13(5)	10(3)	15(5)	5	43(13)
Quail		16(5)				16(5)
Canaries	10(3)	15(5)	10(3)	15(5)	12(4)	62(20)
White-eyes	10(3)	15(5)	10(3)	15(5)	14(3)	64(19)
TOTAL	20(6)	59(20)	30(9)	45(15)	31(7)	185(57)

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 5
JOB NO.: 1

JOB TITLE: Preparation of a Status Report and Species Management plan for the Edible-Nest Swiftlet.

PERIOD COVERED: October 1, 1983 to September 30, 1984

OBJECTIVES

To develop a recovery program and species management plan for the Edible-Nest Swiftlet.

PROCEDURES

1. Synthesize all available data and material in past reports and manuscripts.

2. Supplement with current population counts and cave surveys.

3. Identify management and research needs and make recommendations for future work.

RESULTS

Approximately 29 caves around the island were examined for use by Edible-Nest Swiftlets (Aerodramus vanikorensis) and sheath-tailed bats (Emballonura semicaudata). Only one cave, on the eastern side of Naval Magazine, was currently used by swiftlets. Counts of swiftlets arriving in the evening and departing in the morning revealed that about 250 birds inhabited the cave. Three hundred nests were counted on the cave's ceiling with at least 20 of them judged to be active. Single Brown Tree Snakes (Boiga irregularis) were found close to or inside both entrances of the cave. Of the remaining 28 caves, 18 showed no former use by either species, nine had guano present and one had both guano and old swiftlet nest present.

RECOMMENDATIONS

This job will be completed in conjunction with Endangered Species Project E-1-1 during Segment 22 provided that adequate manpower is made available.

Report prepared by: Gary J. Wiles and Celestino F. Aguon

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 6
JOB NO.: 1(Incl. Jobs 1-3)

JOB TITLE: Impact of Boiga irregularis and other predators on native bird populations. (Consolidation of Jobs 1-3).

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

A study of the impact of the brown tree snake, Boiga irregularis, on Guam's avifauna is in progress. Data indicates this introduced species is largely responsible for the current extinctions and drastic range reductions of the native forest avifauna.

BACKGROUND AND JUSTIFICATION

Guam's native birds have declined drastically in recent decades. Seven species have been recently added to the USFWS. Endangered Species List.

Several species of predators have been introduced to the Mariana Islands including feral dogs, cats, three species of rats, monitor lizards, and brown tree snakes. All of these species probably prey on Guam's avifauna to some degree. However, the brown tree snake was introduced to Guam shortly after WWII and is the only predator occurring on Guam and not in the northern islands.

OBJECTIVE

To determine the impact of predation by Boiga irregularis and other predators on native bird populations.

PROCEDURES

1. Snakes are being collected on a regular basis. Body measurements are taken, sex and reproductive status noted, and stomach and intestinal track examined for remains of prey items. This data is being used to track changes in diet as prey populations decline, to document what prey the various size classes are taking, and to gain information on the age structure of the snake population.

2. A baited funnel trap was developed that has proved successful in capturing Boiga irregularis. These are being placed in various

locations on Guam and Cocos Island to obtain information on predation intensity and on relative snake population densities.

3. Interviews with the public have continued in order to obtain information on snake and rat distribution, and snake range expansion in relation to the avian decline.

4. Distribution and abundance of alternative prey items for the snake, particularly small mammals, are being investigated.

5. Activity patterns, diurnal retreats, and home range of Boiga are being determined by use of radio telemetry.

6. Captive snakes are being measured on a monthly basis and are being used in experiments to determine potential rates of prey consumption.

7. When possible, bird nests are monitored to assess nest predation, and nesting characteristics of less vulnerable avian species are being studied.

RESULTS

Data is currently being summarized for publication. DAWR field records and interviews document the correlation between the range expansion of the snake on Guam and the avian range contraction. Over 200 snakes have been examined. Boiga consumes birds, bird eggs, small mammals, lizards, and skinks on Guam. The largest snake analyzed was 2.6 meters. However, there is a record of a 3.35m snake. Most specimens are .9-1.2m in length.

Predation experiments using funnel traps are in progress. Preliminary data suggests very high snake predation in parts of Guam. A few traps have caught monitor lizards. However, since monitors are diurnal predators, it is doubtful that they are greatly impacting the avifauna. Overall, monitor densities have declined on Guam possibly due to habitat disturbance, hunting, and snake predation on the young. Four instances of monitor predation on adult snakes have been observed, and it may be wise to afford some protection to Varanus.

Although nonnative birds have declined overall, remaining Black Drongos and Eurasian Tree Sparrows reduce predation by nesting on concrete telephone poles and other concrete structures. Black Francolins nest in savannah habitat where due to its arboreal preferences, snake densities are presumably less. Francolins also lay relatively large clutches (5-6 eggs) and may have antipredator behaviors.

RECOMMENDATIONS

1. Summarize and publish existing data.

2. Continue to investigate the life history, feeding ecology, abundance, and distribution of Boiga.

3. Continue to monitor avian nesting success.

4. Continue to investigate the impact of Boiga on alternative prey items.

5. Consider implementing a bounty on snakes to obtain biological data and test the effectiveness as a possible predator control program.

6. Encourage Federal involvement in developing a means for controlling Boiga.

7. Enact legislation protecting Varanus indicus.

Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-2R-21
SUB-PROJECT NO.: W-5
STUDY NO.: 8
JOB NO.: 1

JOB TITLE: Captive Breeding of the Guam Rail and Other Native Birds.

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

Development of a captive breeding program in cooperation with the American Association of Zoological Park and Aquarium and several of its member zoos continued. Remodeling of an existing building for holding Micronesian Kingfishers and construction of 10 aviaries for the Guam Rail were completed. Efforts at capturing and captive breeding Guam Broadbills and Rufous-fronted Fantails were abandoned. Six pairs of Micronesian Kingfishers were captured and sent to Zoos on the mainland for captive breeding. Efforts at capturing Guam Rails were successful with 9 rails, captured and 7 eggs taken from the wild. Efforts at breeding the rails on Guam were successful with 4 eggs hatched after artificial incubation and 3 captive pairs hatching a total of 11 chicks. Four rails were sent to the Conservation and Research Center of the Smithsonian Institute where 4 chicks were successfully hatched.

BACKGROUND

Since the creation in 1960 of the Guam Division of Aquatic and Wildlife Resources (GAWR), census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam Rail and other native birds (GAWR, 1974-1983; Jenkins, 1979, 1983; Engbring, Unpublished Manuscript).

Most native forest birds are now restricted to extreme northern Guam primarily on Andersen Air Force Base (GAWR, 1983). The rail which underwent an 80% reduction in population size in 1983 is now reduced to one known continuous population inside the flightline area on Andersen Air Force Base and a few scattered individuals and family groups found across Andersen AAFB and adjacent areas (GAWR, 1983). One endemic species, (the Guam Broadbill) and two endemic subspecies (the Bridled White-eye and Rufous-fronted Fantail) are now virtually extinct (GAWR, 1983).

Predation by the brown tree snake, Boiga irregularis, is believed to be the major factor contributing to recent declines in native bird populations (GAWR, 1983).

A captive breeding program aimed at preserving in captivity Guam endemic species and subspecies of native forest birds was begun in late 1983 in cooperation with the American Association of Zoological Parks and Aquarium and several of its member zoos (GAWR, 1983). It was decided to breed the Guam Rail both on Guam and at mainland zoos. Other species will be bred only at mainland zoos. By September 30, 1983, one Guam Broadbill, one Rufous-fronted Fantail and 4 Guam Rails were in captivity on Guam.

OBJECTIVES

Implement a captive breeding program for the Guam Rail and other endangered endemic birds by setting up facilities on Guam and in the states with cooperating zoos in the U.S. with the assistance of the American Association of Zoological Parks and Aquariums. Develop techniques for release of captive reared birds in the wild once the factors responsible for their decline have been identified and controlled.

PROCEDURES

1. Consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.

2. Invite various zoos and aviaries to enter into a cooperative program for the captive propagation of the Guam Rail and other native birds, in order that captive populations be maintained at several locations to protect against catastrophic loss and to maintain genetic variability. Request the assistance of the American Association of Zoological Parks and Aquariums in coordinating the cooperating institutions and in developing a captive population management plan.

3. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.

4. Design and construct appropriate holding and breeding facilities (pens and cages to allow birds to be held prior to shipment off-island and to allow for maintenance of a captive breeding population on-island as well).

5. Utilize trapping, mist netting, and other techniques to capture rails and other birds as needed for the captive breeding program. Make an effort to capture mated pairs to increase the probability of success of the program.

6. Develop techniques for the successful release of captive-reared birds into the wild once the factors responsible for their decline have been identified and controlled.

RESULTS

Efforts to locate and capture Guam Broadbills and Rufous-fronted Fantails was abandoned by November 1983. Only 2 broadbills (males) and 5 or 6 fantails (probably males) have been seen since (GAWR, 1984). The single fantail and broadbill in captivity at GAWR at the end of fiscal year 1983 eventually died in January and February perspectively of 1984 of unknown causes (Necropsy report, GAWR, unpublished).

During December 1983 and January 1984, 6 pairs of Micronesian Kingfishers were captured in the Pajon Basin area near Ritidian point. They were held in the newly completed indoor forest bird holding facility at GAWR Office in Mangilao. They were then transported to the Philadelphia Zoo (5 pairs) and Bronx Zoo (1 pair) in late January. Airfare was paid for by the Philadelphia Zoological Society. By September 1983, 2 pairs remained at the Bronx Zoo, 2 pair were at the Philadelphia Zoo and 2 pair were at the Conservation and Research Center (CRC) of the National Zoological Park at Front Royal, Virginia. None have bred to date.

Ten outdoor aviaries, 10'x10'x4', were constructed to hold and breed rails at the GAWR office in Mangilao. A successful technique for capture of the rail in descrete habitat patches was developed. Rails were "driven" into a ground level mist net after being surrounded by 20-40 volunteers. In addition eggs, chicks and adults were captured by various other means.

The first hatching of a rail chick as a part of our captive breeding program occurred at GAWR facilities on April 17, 1984. Later during the summer, 11 additional chicks were hatched from captive parents on Guam. In addition, we were successful in rearing 4 chicks captured in the wild and artificially incubating and hatching 4 eggs captured from the wild.

In late March Dr. Eugene Morton, Curator of Birds, National Zoological Park, visited Guam to assist us in capturing Guam Rails. He returned to the CRC with 4 rails captured during his stay. One of the pairs had hatched 4 chicks from 2 clutches by September, 1984.

At the end of the fiscal year, September 30, 1984, we had in captivity on Guam 21 rails. Twelve kingfishers and 7 rails were in captivity at zoos in the states.

Applications for federal Fish and Wildlife (Endangered Species) Permits to cover our captive breeding activities were submitted in November, 1983 in anticipation of federal endangered species listing of several species of Guam's native wildlife. The Guam Rail was "emergency listed" on April 11, 1984, and an Endangered Species Permit to cover our rail activities was issued on June 15, 1984. The rail and 8 other native species were formally listed as endangered on August 27, 1984, and a permit to cover captive breeding and other activities with these species was issued October 15, 1984.

RECOMMENDATIONS

1. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.

2. Continue the development of a cooperative captive breeding program for the Guam Rail and Micronesian Kingfisher with the AAZPA and its member zoos. Captive populations should be maintained at several locations to protect against catastrophic loss and to maintain genetic variation.

3. Development ofa captive breeding techniques for the Marianas Crow, Corvus kubaryi, should begin due to its restricted range and numbers (GAWR, 1984).

4. Upgrade and enlarge the Guam Rail breeding facility at GAWR office in Mangilao to allow up to 50 birds to be held in captivity.

5. Continue to develop capture technique for the Guam Rail and other forest birds as needed.

6. Seek funding for transport of birds to zoos for captive breeding for conservation organization and other private sources.

7. Conduct study of breeding biology in the field on Guam of birds that are to be captive bred.

8. Develop techniques for successful release of captive reared birds into the wild.

LITERATURE CITED

Engbring, John. 1982. Distribution and abundance of the forest birds of Guam: Results of a 1981 Survey. U.S. Fish and Wildlife Service.

Guam Aquatic and Wildlife Resources Division, 1974-1983, Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Guam, Dept. of Agriculture.

Jenkins, J.M. 1979. Natural history of the Guam Rail. Condor 81:404-498.

Jenkins, J.M. 1983. The native forest birds of Guam, Ornithological Monograph #31, American Ornithologists Union.

Report prepared by: Robert E. Beck, Jr.

GUAM ENDANGERED SPECIES INVESTIGATIONS
PROJECT E-1-1
Section 6 - Endangered Species Act of 1973

JOB PROGRESS REPORT
RESEARCH PROGRESS SEGMENT

STATE: Territory of Guam

PROJECT NO.: E$-1
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Investigations into the Biology of the Monitor Lizard and the Brown Tree Snake.

PERIOD COVERED: October 1, 1983 to September 30, 1984

SUMMARY

A study of the impact of predation on Guam's avifauna and of the biology of predators including Boiga irregularis and Varanus indicus is in progress.

OBJECTIVES

To design and implement a study of the life history, feeding habits, and activity patterns of the monitor lizard (Varanus indicus) and brown tree snake (Boiga irregularis).

Because this job was conducted in conjunction with Job W5-6-1, PROCEDURES, RESULTS, AND RECOMMENDATIONS are reported under that job.

Report prepared by: Julie A. Savidge

JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1
STUDY NO.: 1
JOB NO.: 6

JOB TITLE: Impact of Avian Disease on Guam's Native Bird Populations.

PERIOD COVERED: October 1, 1983 to September 30, 1984.

SUMMARY

A study of the impact of avian disease on Guam's bird population is in progress. To date, there is no data implicating any infectious disease.

BACKGROUND AND JUSTIFICATION

Guam's native birds have declined drastically in recent decades. Seven species have been recently added to the USFWS Endangered Species List. Introduced diseases have been suggested as a possible cause of the decline. Warner (1968) proposed that extinction of nearly half of the endemic Hawaiian land avifauna was due to the pathogenicity of avian malaria, pox, and other possible introduced diseases.

An extensive survey of avian disease on Guam is being conducted to determine if disease is the cause of the avifauna decline.

OBJECTIVE

To determine the presence and impact of avian disease on Guam's bird populations.

PROCEDURES

1. Sample native birds, sick birds of all types, and potential bird species that may serve as disease reservoirs including sparrows, quail, pigeons, and chickens. Samples include any or all of the following procedures: blood smears, blood collection for hematocrit and serum, swabs (cloacal, tracheal) for routine bacterial culture and Salmonella sp. determination and for egg and cell culture inoculation for viruses, and tissues for histopathological examination. Bacterial, viral, and histological samples are being analyzed by the National Wildlife Health Laboratory.

RESULTS

Survey results are currently being summarized for publication. Samples analyzed by the U.S. Fish and Wildlife National Wildlife Health Laboratory have not revealed any infectious disease capable of causing the declines. Approximately 200 blood slides representing 10 orders 17 families, and 28 different species have been analyzed by DAWR personnel. All questionable slides are examined by the National Wildlife Health Laboratory. To date, no hematozoa have been observed.

RECOMMENDATIONS

1. Summarize and publish existing data.

2. Future sampling should concentrate on blood smears from native birds, sick birds, and potential disease reservoirs.

LITERATURE CITED

Warner, R.E. 1968. The role of introduced disease in the extinction of the endemic Hawaiian avifauna. Condor 70(2):101-120.

Report prepared by: Julie Savidge

Law Enforcement

LAW ENFORCEMENT

During Fiscal Year 1984, the Conservation Officers arrested a total of sixteen people for violating the Fish and Wildlife Laws. Twelve of these individuals were arrested for hunting illegally, by either possessing deer carcasses or using an artificial light as an aid to take wild game. Four individuals have already pleaded guilty and the remaining eight are awaiting prosecution. The four other individuals were arrested for fishing with explosives and whereby two boats were confiscated as evidence. Two have already been found guilty and the remaining two are to be tried in October. The two boats were ordered forfeited by the court and turned over to the Division of Aquatic & Wildlife as a result of the two persons being found guilty.

A great amount of time was spent in court during this period by the Conservation Officers as they not only appeared to testify for the above mentioned arrests but also to testify on two separate illegal hunting cases which were made during the last fiscal year. Of these two cases, four individuals were involved whom were arrested for possessing a deer carcasses. They were all found guilty.

The Conservation Officers also recorded the following as incidents, since they didn't turn into arrest cases. Twenty-six illegal hunting incidents; nine fish poisoning incidents; eight fish dynamiting incidents; eleven turtle hunting incidents; three illegal harboring of wild game incidents; one live coral harvesting incident; and five abandoned gill-net incidents. The above amounted to sixty-three (63) incidents.

The deer control on the runways at Andersen Air Force Base was terminated on the 25 of September 1984 until further notice.

On May, 1984, the Enforcement Office was burglarized. Entry was made through an air conditioner's window after pushing in the air conditioner. Pad locks were broken off from two freezers and one wall locker. Attempts were made to take several whole deer carcasses but since they could not fit through the window, the front and hind legs of one carcass were cut and taken. The other carcasses were left lying outside the freezers. The incident was reported to DPS.

One Conservation Officer I was recruited as a full-time employee and at present is undergoing training at the Police Academy. He is expected to graduate in February 1985.